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PROTECTING NIAGARA FALLS.

What may be an important step in legislation to protect Niagara falls and retain the scenic beauty of that wonderful cataract was taken in the senate of New York state on Monday, March 12, by the passage of several bills repealing the charters of several companies which had been granted the rights to utilize the water of the Niagara river for power purposes. This action of the senate, if sustained by the lower house and approved by the governor, will leave only two charters on the New York side—that of the Niagara Falls Power Company and that of the Niagara Falls Hydraulic and Manufacturing Company.

The action of the New York legislature will, however, not accomplish the desired result if similar action be not taken by Canadian authorities. The crest of the Horseshoe fall is about ten feet lower than that of the American fall, and over the former passes about nine-tenths of the total flow of water; and although the international boundary line passes down the centre of this fall, no action on our part alone can affect, to any extent, the flow of water in the Canadian half of the stream. In fact, the power plants now in course of erection on the Canadian side together will take two or three times as much water as that diverted on the American side.

It is rather interesting at this time to recall the statement made by Mr. P. N. Nunn in his paper before the Asheville (N. C.) convention of the American Institute of Electrical Engineers, in which he describes the Ontario Power Company's new installation. Mr. Nunn said that the variation in the height of water at the falls due to the direction of the wind is much more than that which would be caused by the water drawn off through the power-houses; yet nobody notices the difference at the fall.

ELECTRIC POWER IN THE SHOE FACTORY.

An attractive field for the application of electric power is found in the shoe-manufacturing industry. Thus far comparatively little has been done in the way of modernizing the motive power of shoe factories, but there is ample reason for attacking the problem in the light of recent experience. The Haverhill Electric Company, in Massachusetts, has lately installed the motor drive in several important shoe factories, arranging the equipment largely on the group system, with 550-volt, three-phase, sixty-cycle motors of the induction type in each separate or subdepartment.

The advantages of the modernized equipment in the shoe factory are essentially those which have given electric power so vast a hold in other industries. The reduction of shafting and belts is especially noteworthy, for in the manufacture of a modern shoe some fifty-six different processes enter, with over one hundred different handlings. Human labor plays a most important part in this work, and anything which improves the operating conditions of the trade is a definite stimulus toward increased production. The distribution of both natural and artificial light is improved by the elimination of any shafts or belts formerly necessary with steam engine driving, and the ventilation is certain to be somewhat better upon the electric motor basis. The amount of power required to drive a shoe factory is not large in comparison with that needed in many other industries, but the percentage of power wasted in belt transmission is food for thought in the production of shoes—a business in which competition is exceptionally keen.

The induction motor is specially suited to the group driving

of shoe machinery, requiring, as it does, little more than nominal attention. Its reliability and freedom from commutator troubles are cardinal points in its favor, for continuous operation is most essential to the maximum production economy in any plant where the labor cost is high and where the manufactured article passes through a long chain of processes. In the Haverhill installations the use of 550-volt motors permits the enjoyment of the electric drive with very moderate power losses in the distributing system, and with proper care as to insulation there should be little more danger to employés than with half the Haverhill working voltage.

An important phase of the electric driving problem in the shoe factory is the opportunity it gives the central station manager to present the claims of high-efficiency electric lighting in larger units than sixteen candle-power. Gas is nowhere more out of place than in a large plant employing hundreds of men and women under conditions of ventilation which are difficult to improve at any season of the year. There is a good field for large electric fans in the shoe factory during the trying days of midsummer. The power business of a single shoe factory may be a comparatively small matter, but if it is supplemented by the use of large quantities of light derived from the later types of air and incandescent units, the sale of current should be profitable in every case.

ADULTERATION OF ELECTRICITY.

It is a well-known saying that electricity is one supply which can not be adulterated, that the user gets only the simon-pure article, though perhaps sometimes his supply is not quite as regular as he could wish. In a recent paper read before the Manchester section of the Institution of Electrical Engineers, of Great Britain, Mr. M. B. Field admitted the general correctness of this statement, but he said that in a general way adulteration of the current did take place, at least from the generating station's point of view. Leakage currents—that is to say, currents which are sent out from the station, but do no useful work—might be considered as adulterations to the useful current. With alternating-current systems the so-called wattless component of the current may be looked upon in the same way, and, under certain conditions, cross or idle currents may be set up, which cause a loss of power and poor regulation at the station, but produce no useful results.

By stretching the point a little, this way of looking at matters may be allowed, but there is a difference. In adulteration, as usually practised, the purchaser pays for something he does not want and gets the article he does want in an impure condition. With the electrical supply it is just the other way; the manufacturer produces something that he does not want and which he can not sell. The purchaser of electrical energy suffers only in a secondary way. His wattmeter, if correct, does not charge him with wattless currents; the leakage currents, as a general thing, get back to the station without passing through his premises. If his installation has been made properly he pays for only what he uses. In fact, he himself is sometimes to blame for the poor character of the load on the generating station. In a sense, adulteration is caused, but the consumer does not pay for it, except in so far as his bills go toward bearing the general expense of the system.

MUNICIPAL OWNERSHIP AGITATION.

When the mayor of Chicago secured the services of the Glasgow (Scotland) street railway expert to report upon the feasibility of taking over her street railway systems, the advocates of municipal ownership began to crow loudly, as they expected a report in every way favorable to their cause. Mr. Dalrymple, however, took a common-sense view of the situation and reported adversely, much to the chagrin of those who had anticipated so much aid from him. His report was not made public, although his general conclusions were known. This report has now been secured and published, and although it does not add much to what has already been said, it contains a timely warning. It says: "presuming that you are able at a satisfactory figure to purchase the present franchises, there would undoubtedly be a very grave danger in your city attempting to operate what would be the largest street railway undertaking in the world without making a very radical change in the methods usually employed in carrying out municipal work of the cities of the United States." This is the danger that the municipal ownership advocates seem to be so blind to—so blind, in fact, that although one day they may be heard criticising most strenuously the working of certain city departments, the next day they are just as loud in urging that the city take upon its shoulders still greater burdens.

Another expert, who was sent abroad to look into the municipal operation of public utilities, also reported adversely not long ago. Professor F. H. Roberts, of the University of Colorado, who was sent abroad by the governor of that state, reported as follows: "from all I can make out, the entire municipal ownership system in England and on the Continent is unbusinesslike in the extreme. In the first place, nearly all the towns are failing to make provision for depreciation of the plants—lighting, railway, water, whatever they are operating—in order to make a better showing for the scheme at present. For instance, in a number of towns the sinking fund set aside is one per cent, or even lower. Seven or eight, or even ten per cent is set aside by conservative business concerns in this country, and they are not putting by more than they deem necessary." If we could get at the true situation, it is very probable that municipal ownership would be less attractive to those who are really concerned in developing the city and in improving its government.

These phases of the subject consider only the side of the public. There is another side—that of the electrical industries. It seems to have been pretty well demonstrated that when an industry or a business is conducted by the government it is impossible for it to keep up with the progress of the art. Government systems are notorious for their inadequate methods and useless apparatus, and although the system, when first installed, may be as good as can be secured, it soon becomes old and gives poor service. Not only does the public suffer, but the development of the art itself is greatly retarded.

CHEMICAL PROBLEMS IN ELECTRICAL ENGINEERING.

In the ELECTRICAL REVIEW for February 17 attention was called to certain power-house problems which for their best solution require a knowledge of chemistry, if not, indeed, the services of an expert chemist. On another page of this issue we publish a letter from Mr. Charles E. Farrington on the same general subject—the value of chemistry to the electrical industries.

The particular phase of work referred to by Mr. Farrington is the need of chemical knowledge in selecting or preparing insulating materials. The insulation of an electrical machine is, generally speaking, its weakest feature, because the materials most suitable as non-conductors generally have poor mechanical strength. This is well known and an ample factor of safety is usually provided, and care is taken not to subject them to undue mechanical strains. But many insulating materials are subject to other sources of weakness which the user does not always suspect and can not detect without a chemical test. The use of varnishes, paints and other compounds for improving the insulating covering of electrical conductors is very general. Such materials are employed not only for saturating the insulating fabrics, but for cementing together mica sheets. Their use improves the mechanical qualities of the insulation and makes possible the construction of solid insulating parts with considerable mechanical strength, such as are essential in the manufacture of almost every electrical appliance employed for moderate or high potentials. The method of making them not only produces a fairly satisfactory article from a mechanical standpoint, but enables use to be made of materials which otherwise would be useless. But if the article is to be entirely satisfactory it must meet requirements other than those merely mechanical or even electrical.

The engineer has no difficulty in determining the mechanical strength of his insulating material. He can also test its electrical properties without much trouble, and he is likely to think that if it meets the requirements in these two ways it is entirely satisfactory. There remains, however, the chemical side of the problem. The insulating compound or cement may give sufficient mechanical strength, and it may seem, on test, when it is fresh to satisfy the electrical requirements; yet it may contain chemical constituents which, given time, will ruin it for insulating purposes. Both vegetable and mineral oils and gums frequently contain acids or other chemical agents which have the ability to corrode or destroy metals and vegetable fabrics. These acids should, of course, be entirely removed before the material is used for insulating purposes, and such substances should always be subject to chemical test to ascertain their purity.

There are other chemical problems which may arise in electrical work. Only recently we called attention to the corrosion of the conductors in a high-potential, alternating-current generator. It was said that chemical test proved the presence of nitric acid—or rather copper nitrate—which was supposed to have been produced by brush discharges from the machine. It might possibly have resulted from the use of an impure shellac, though this was said not to have been the case. There was no doubt, however, that corrosion had taken place, and whether it were caused by the use of impure insulating materials or the oxidation of atmospheric nitrogen, the effect was chemical, and the remedy should be sought through that science.

IMPROVING THE LAMPS.

A statement was made recently by an architect that it is far more important to secure a lamp satisfactory aesthetically than it is to improve the efficiency of the lamp as a source of light. There is a certain amount of force in this statement, for the cost of fixtures in a building is but a small part of the total expenditure, and it is therefore the more necessary that this comparatively minor feature of lighting should be in harmony with the whole scheme. The architect holds that if a sufficient amount of illumination be secured, the power required to do this is a secondary matter. His first object should be to get a pleasing effect.

On the other hand, the engineer has good excuse for his efforts to increase the efficiency of artificial illuminants. If our modern lamps had a decent efficiency there would be less reason for this energetic search for improvement. Could the lamp compare with the generator or even the engine as a transformer of energy, the manner in which this is done might be left largely to the architect, but unfortunately our incandescent lamps are notably inefficient, not as compared with other types, but as compared with other energy transforming devices; and, moreover, this most inefficient device of the whole lighting system is used for the final transformation—the worst possible position. If the most inefficient device could be used for the first transformation, all succeeding devices could be correspondingly smaller or do correspondingly greater amounts of work. But with an efficiency of, say, five per cent at the final stage, all devices intervening between this one and the coal pile must be about fifteen times larger for the same amount of work than would be required had the lamp itself a respectable efficiency. If a lamp could be given an efficiency of seventy-five per cent, not only would the coal pipe represent about fifteen times as much light as it does to-day, but every lighting station would have its rating increased correspondingly.

To-day there is no evidence of any such improvement, but there is hope for a much better lamp than those in general use, and it is the duty of the engineer to make every effort in this direction. That recent progress has led to greater intrinsic brilliancy and lamps of higher ratings is unfortunate from the architect's viewpoint, but it does not follow that all future progress will be in the same direction. If a highly efficient lamp with a small rating can be made satisfactorily, the architect can afford to use translucent globes and will still get his desired effect. At the same time, the efficiency of the system as a whole will be improved. Every engineer must hope for a great improvement in the efficiency of our sources of light. From his standard the objections raised by the architect are secondary and can be overcome without much difficulty after the desired progress has been made.

The Illuminating Engineering Society.

The second regular meeting of the Illuminating Engineering Society was held at the Edison auditorium, 44 West Twenty-seventh street, New York city, Friday evening, March 9. The meeting was called to order by President L. B. Marks.

A paper was presented by Mr. Victor A. Rettich, entitled "The Inverted Gas Mantle Lamp." Mr. Rettich sketched the history of this type of mantle burner, pointed out the improvements sought by the new arrangement and the difficulties encountered. Care must be taken to secure complete combustion of the gas, the construction must be such as to reduce the chance for flashing back at the moment of lighting, the products of combustion should be properly conducted away and provision must be made to catch any incandescent particles which might drop from the mantle. A number of lamps were described, showing how different inventors had endeavored to secure the above requirements; but Mr. Rettich did not feel that the lamp in its present state could be considered a success.

A paper was read by Mr. E. Leavenworth Elliott, entitled "The Flaming Arc Lamp." Mr. Elliott reviewed briefly the history of this arc lamp, noting that a patent for a flaming arc had been taken out in the seventies, and, in fact, the effect upon the arc produced by introducing salts into the carbon electrodes had been mentioned a good many years before. After the development of the commercial type of arc lamp, manufacturers devoted their efforts to improving the life of the carbons, the efficiency of the lamp and the quality of the carbons. After a high stage of development had been reached, progress took a new trend when the enclosed arc lamp was invented. This has a lower efficiency, but requires less trimming and produces less glare, due to the apparent lower intrinsic brilliancy. During the last few years the problem of increasing the efficiency of the arc light has been taken up again and the flaming arc type revived. Incandescent carbon and transparent gases are unfortunately inefficient light radiators. The efficiency of the arc can be enormously increased by introducing materials into the arc. This is done in the flaming arc type. Bremer is given the credit for the first commercial results. Mr. Elliott objected to the term "flaming arc," which has become common, as he thought that it was misleading. He suggested that a better term would be "luminous arc."

Different qualities of light can be obtained with the luminous arc by adding different salts to the electrodes. The calcium salts give a golden-yellow color, which is very striking and good for exterior lighting. It is a penetrating light which reaches far through fogs and mists. A white light can be obtained, using certain salts without difficulty, but it happens that the materials which produce the white light give a much lower luminous efficiency.

The addition of salts to the electrodes for luminous arcs unfortunately causes a slag to form, which may interrupt the circuit if the arrangement of carbons be not such as to prevent it. It is to avoid this trouble that a return has been made to the old Jablochkoff principle, the carbons being placed nearly parallel. This has the advantage of doing away with a lower support, which casts a shadow.

The fundamental patents for the use of impregnated carbons have long since expired, but the methods of making these have been treated as trade secrets, though they are pretty generally known. The electrodes of such lamps burn away rapidly and generally give off undesirable products of combustion and must be taken care of. Mr. Elliott referred to a report of a recent German invention in which the lower carbon is said to be surrounded by mercury and the length of life increased to about 1,600 hours. No details of this lamp could be given.

Mr. W. S. Kellogg presented a short paper entitled "Artificial Illumination from the Architect's Standpoint." He pointed out certain qualities of lamps desirable from an æsthetic viewpoint, holding that a pleasing effect is much more important than energy efficiency. High intrinsic brilliancy is a bad factor, and it is unfortunate that recent attempts to increase the efficiency of illuminants have always tended toward an increase in the brilliancy. Lamps should always be well shaded, except where used for advertising purposes. At the present time the sixteen-candle-power incandescent lamp is the standard, but the tendency is upward, and the lamp manufacturers cater to this because of the better efficiency obtained. Mr. Kellogg spoke of the difficulty of obtaining a satisfactory standard rating for illuminants, particularly since the use of reflectors is coming in so widely. It is this uncertainty in the rating of the lamps that forces the architect to provide a large number of outlets, as only in this way can he protect himself against unsatisfactory illumination.

The discussion was opened by Dr. E. L. Nichols, of Cornell University, who spoke of the great need for reducing the art of illumination to a scientific basis. Although we have been using artificial illuminants since time immemorial, we are still guessing about light; yet this art can be reduced to as exact a science as any other. It is time that we should stop measuring candle-power and begin to measure the luminous effect. We should educate the public not to look at the light, but at the lighted object, and it is time to begin the education of the engineer as well.

Mr. George G. Ramsdell, New York city, took a stand opposite to that of Mr. Rettich in his discussion of the inverted gas mantle. Mr. Ramsdell said that the progress which had been made in the last year or so has been noteworthy, and although the inverted mantle type is not yet perfect, he thinks that there is a great future for it.

Mr. E. C. Brown, New York city, took somewhat the same stand. He has used two of these lamps, which have given very satisfactory service, and he has much faith in the future of the lamp.

Dr. Clayton H. Sharp, New York city, compared the action of the salts in the electrodes of the luminous arc to that of the mantle in the incandescent gas light. Both are methods of rendering a non-luminous gas luminous, one by a permanent body, the other by introducing continuously bodies which make the flame luminous.

It is a puzzle to explain the action of the mantle, and the fact that the composition of the mantle is limited to certain percentages of thoria and ceria renders the puzzle more puzzling. Several explanations have been offered, one by Dr. Nichols, who attributed the action of the mantle to luminescence. Another suggestion is that it is due to catalytic action of the ceria, and a third to the high temperature attained by the mantle. The work of Rubens on the distribution in the spectrum of the energy radiated by the mantle shows that the greater proportion of this lies in the visible spectrum. The power radiated as heat is comparatively small, and although there is an increase in the radiation for very long wave-lengths, the energy represented by this is slight. Nearly all of the energy radiated is in luminous waves. A pure thoria mantle behaves almost as a transparent body, having no radiating power. The addition of ceria may be compared to adding a colored body—that is to say, a body having what may be termed "light color" rather than "heat color." It adds to the thoria mantle, which is a poor heat

radiator, the power to radiate light. For this reason the temperature attained must be very high.

Dr. Sharp warned engineers against ill-considered use of the luminous arc. Its intense brilliancy can not but have a detrimental effect upon the general illumination of the streets where it is used. The lamp should be put well up out of the way.

Dr. Nichols added a little to Dr. Sharp's explanation of the action of the incandescent mantle. His explanation is nothing more than a surmise, but it is based upon several well-known facts. To obtain a fluorescent solution but a small percentage of the fluorescing material should be added to the solvent. This agrees with the limits found in the manufacture of the mantle. Luminescent substances are luminescent at definite temperatures, and the mantle may happen to be luminescent at the temperature of the Bunsen flame. All known luminescence lies in the luminous spectrum, covering one broad band, which would explain the high efficiency of the mantle. It is on these similarities that he bases his surmise, but he warned his audience that it was merely a guess. Dr. Nichols believes that the study of the gas mantle may lead to a general improvement in the art of illumination.

Mr. W. D'A. Ryan, West Lynn, Mass., exhibited a number of curves showing the distribution obtained by different types of arc lamp. These included the open arc, the enclosed arc and the flaming or luminous arc. The distribution given by the open arc is most suitable for street lighting, since the greater percentage of light is thrown out more nearly horizontal. Most of the developments in arc lighting have been away from this feature, notably in the case of the luminous arcs, where nearly all the light is thrown down under the lamp. A notable exception to this is the magnetite arc, which has a distribution resembling that of the open arc, but more marked, in that a still larger proportion of the light is thrown out in a nearly horizontal direction. It is this type of lamp which should be used for exterior lighting. Attention was called also to the great reduction in light radiation due to the use of opal globes. The loss was attributed to exclusion of air, which reduced the efficiency of the arc; to absorption of the glass and to reflection from the inner surface of the globe.

During the meeting four flaming or luminous arc lamps were exhibited. Three, two Siemens' and one Excello are for exterior lighting. The fourth, a new Excello type, is for interior use and gives out a white light.

CONDUIT WIRING FOR ELECTRIC INSTALLATIONS.[1]

BY L. M. WATERHOUSE.

I will now deal with some points in the conduit wiring of installations on which it appears to me that discussions would be most valuable, both from the manufacturers' and contractors' point of view, and should ultimately lead to the betterment of installation work as a whole. I would first direct your attention to an interim reissue of the rules of the Royal Insurance Company. These rules, embodied by consent of the council, are uniform in requirements with the rules of the Institution of Electrical Engineers, of Great Britain. On page 18 we have the following: "In the opinion of this company the best general method of enclosing and protecting the conductors is by the use of stout metal conduits. It is important to note, however, that numerous fires have occurred through leakages of the current from such conduits to soft metal gas pipes, so that the security of such a system depends seriously upon the proper spacing apart of such conduits from soft metal gas pipes or from metal work in contact therewith." This note deals with one of the real risks in connection with the conduit wiring of buildings, and a risk that will remain just so long as we continue to permit the use of gas pipes of the compo description. Continuity and earthing are no doubt very advisable on high-voltage work from the point of view of protection from danger to life, but are really very little safeguard against fire risk unless care is taken to keep metal conduits spaced apart from such gas pipes, and of course from any metal work in connection with them.

The present chief engineer of Glasgow, Mr. W. W. Lackie, in his paper on "Earthing" read before the Glasgow branch of the Institution of Electrical Engineers, in February last year, laid it down that conduits should be entirely insulated throughout a building. This is most desirable, and if it were possible in practice, I believe that it would at once remove the only real cause of uncertainty connected with the use of metal conduits.

I should like to refer to some points of importance which were brought out in that. First, we had a report on fires having electrical origin, and during three years, 1902-4, thirty-five fires were reported. On examination these were reduced to thirty-three, or an average of eleven a year; this works out at one fire per 900 installations, and shows how essentially safe electric lighting is. Of these electrically caused fires one-half, fifteen, were due to the melting of compo gas tubes, where metal-sheathed cables were used. Now eight of these jobs were carried out without being properly earthed, and seven were properly earthed; what the other causes were does not particularly concern us at the moment, but the point I want to emphasize is that continuity and earthing alone do not, as is commonly supposed, safeguard against fire. Suppose we have a leak on one of the outers of a three-wire system, the neutral of which is earthed, the tubing if continuous becomes alive throughout its length. Now the tubing may be earthed by an earth wire or not, it is quite possible that it may also be unintentionally earthed at one or more points by contact with compo piping; the result is that there is a large momentum rush of current to earth which splits up amongst the different earth paths in the ratio of their conductivities, and it is the arcing and consequent gas igniting effect of these earthing discharges which is the cause of danger. To entirely eliminate this we must insulate conduit runs, as far as practicable, from all metal work, or we must remove all compo gas tube from the building.

Now, there are many thousands of socket-joint installations erected during the last eight years which are to-day working very satisfactorily, but these have been erected without any attempt being made to secure continuity or bonding, and consequently they are not intentionally earthed. The Institution of Electrical Engineers in their wiring rules do not demand continuity and earthing in jobs where the voltage of supply does not exceed 250 volts. Their rule dealing with this is important: "Conductors conveying currents at pressures exceeding 250 volts must be completely encased in metallic sheathing or tubing efficiently connected to earth, and such sheathing or tubing must be electrically continuous throughout its length." We can draw the following deductions from this rule: first, that metallic sheathing continuous and earthed is the only method permissible with conductors on high-voltage work; second, that it has not been deemed expedient to prohibit the use of socket-joint tubing on voltages below 250.

In dealing with this method of installing conduit the question arises: "Is it desirable to use a brazed or solid-drawn tube, or is it not actually advan-

[1] Abstract of a paper read before the Electrical Contractors' Association of London, on Tuesday, February 20.

tageous to use an open seam and socket fittings?" I have it from more than one consulting engineer that for surface work they advocate the use of open seam conduit, and some of them go so far as to say that they would prefer to adopt tubing with even a more open seam than is now used, always provided that the seam is placed lowermost, so as to efficiently drain the tube; but it is reasonable to suppose, and is acutally borne out in practice, that with such a well-ventilated tube there is absolutely no condensed moisture to drain, and it is for this reason more than anything else that, in my opinion, an open seam is desirable. In situations where there is steam or vapor about or humid atmosphere, such as in baths, laundries, boiler rooms, etc., the moisture from the outside is more to be feared than condensation, and in these cases the use of seamless screwed tube is desirable.

With regard to concealed work, switch runs and the like, I think there is no doubt that open seam conduit is unsuitable wherever switch runs are buried in plaster or cement, and I do not think it has ever been recommended for this purpose. These runs, terminating very often in a switch wall plug or section box, act as natural drains for any condensation which may take place in the horizontal runs, and I think it is desirable that an outlet should be given to them, say by using a T-piece instead of a bend, so as to prevent this moisture draining into the switch box.

With regard to switches and ceiling roses and their mounting I think it will be agreed that for the sake of continuity throughout the run it is most desirable that metal boxes should be used wherever an outlet is required. The circular conduit box is usually supplied with lugs which are drilled and tapped, and holding-down metal screws are used to pass through the porcelain base, but owing to the proximity of these metal screws and the live terminals on the switch or ceiling rose the leakage path to the conduit or earth is now very greatly reduced; in some cases it may not be more than one-eighth inch, and on a large installation this has a very marked effect on the test. Good seating is also desirable to even up any inequalities in the china or porcelain base. Another method, which reduces the projection, is to use a ring provided with a lip, something after the nature of the cover of a paint tin. This would be put on the base of a ceiling rose with a small rubber washer, and after wiring the lid would be screwed home; this metal ring would then be gripped tight into the box, and to prevent subsequent loosening by vibration or any other cause it is held in position by two screws on the outside.

It is pointed out that a great point in favor of a conduit is that it should be capable of being easily bent cold without flattening or splitting, that is, it must be well annealed and ductile; on the other hand it must be of sufficient mechanical strength to resist penetration, and, unfortunately, these two requirements are not compatible.

In conduits and fittings a certain standard of workmanship and finish should be kept up, and for the production of an efficient article it should be recognized that certain processes in manufacture are essential, and I feel that I can safely leave it to electrical contractors as a body to say that what I venture to describe as the present satisfactory state of conduit manufacture shall not suffer by a demand for the cheapest article attainable, irrespective of finish and general suitability.

Voltage and Costs of Electric Transmission Lines.

Distance, says Mr. Alton D. Adams, rather than voltage, is the prime factor in the cost of transmission lines. Contemplation of that beautiful law of electric circuits, that the percentage of power lost and also the weight of conductors remain constant if the applied voltage varies with the length of line, sometimes obscures the fact just stated, but a cold engineering estimate brings it again to view. If electric conductors floated in mid-air and did not require any particular mechanical strength, the question of line voltage would indeed be one of first importance; but as long as poles, pins and insulators are necessary, the question of line cost is not merely one of voltage, as is sometimes said. Costs of transmission lines may be divided into those for conductors and those of supports. Within rather narrow limits the cost of conductors may be held constant by varying the voltage directly with their length. Over much wider limits the cost of supports for the conductors varies nearly as their length, whatever the voltage employed. For rather short transmissions, where the total cost of the line is only a moderate fraction of the investment in the entire plant, there is not so much reason to lay stress upon the distinction between the cost of conductors and that of supports; but on long lines, such as that talked of for the Victoria falls transmission, the cost of supports alone becomes one of the main items, if not the greatest item of the investment. The fact that the weight and the cost of conductors for a given percentage of loss remain constant if the voltage increases directly with their length, while the cost of conductors increases nearly at the same rate as the length of line, implies a constant approach of the cost of supports to that of the conductors. Were it not for the circumstance that in practice the cost of conductors can not be held constant over any great range, the cost of supports would rise above that of line wires long before the limits of existing transmissions were reached. Constant reduction of mechanical strength in the conductors puts a limit to the practical voltage of many lines, but reduction in the size of the conductors due to an increase in voltage would, in many cases, not decrease the cost of supports. For a modern three-phase, 50,000-volt transmission, with each three-phase circuit on a separate pole, with the poles thirty-five feet long, 100 feet apart, the wires of No. 1 B. & S. gauge six feet apart, the cost of the line per mile is about equal to that for the cost of supports. Since it is undesirable, in general, to use a lighter wire than this, the cost of supports of such a line would be equal to the cost of the conductors, no matter how long the line be. Using steel towers similar to those of the Guanajuato transmission in Mexico, the cost of the supports in this country would be about seventy per cent greater than that of the single, three-phase, No. 1 B. & S. circuit.—*Cassier's Magazine (New York), March.*

American Institute of Electrical Engineers.

The next regular meeting of the American Institute of Electrical Engineers will be held Friday evening, March 23, 1906, at 8.15, in the assembly room of the New York Edison company, 44 West Twenty-seventh street. The following papers will be read and discussed:

"Some Features Affecting the Parallel Operation of Synchronous Motor-Generator Sets," by J. B. Taylor, railway engineering department, General Electric Company, Schenectady, N. Y.

"Notes on the Design of Hydroelectric Power Stations," by D. B. Rushmore, General Electric Company, Schenectady, N.Y.

"The Influence of Load-Factor on Hydroelectric Plants," by S. B. Storer, Niagara, Lockport & Ontario Power Company, Buffalo, N. Y.

The Electrical Equipment of a Two-Million-Bushel Grain Elevator.

THE operation of grain elevators is a remarkably successful field for the induction motor. The sturdiness, simplicity of construction and operation, economy of maintenance and freedom from sparking of this type of electric motor make it ideal for the exacting conditions of use in the dusty and inaccessible confines of a grain elevator.

Grain elevators are of two types: operating elevators and storage elevators. The Weehawken, N. J., elevator, which appears in the foreground in the accompanying illustration, Fig. 1, is of the operating type, and is designed to handle grain arriving mainly by rail. The building is 353 feet long, 101 feet wide and 200 feet high, has a capacity of 2,000,000 bushels of grain, and contains 291 separate bins.

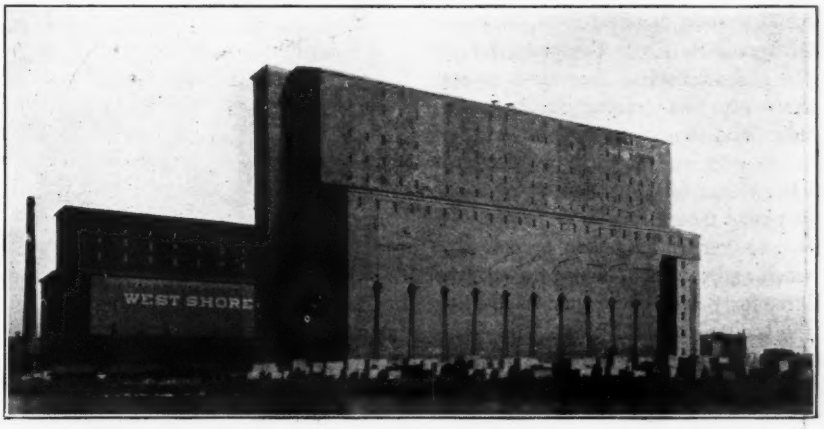


FIG. 1.—TWO-MILLION-BUSHEL GRAIN ELEVATOR OF THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD, WEEHAWKEN, N. J.

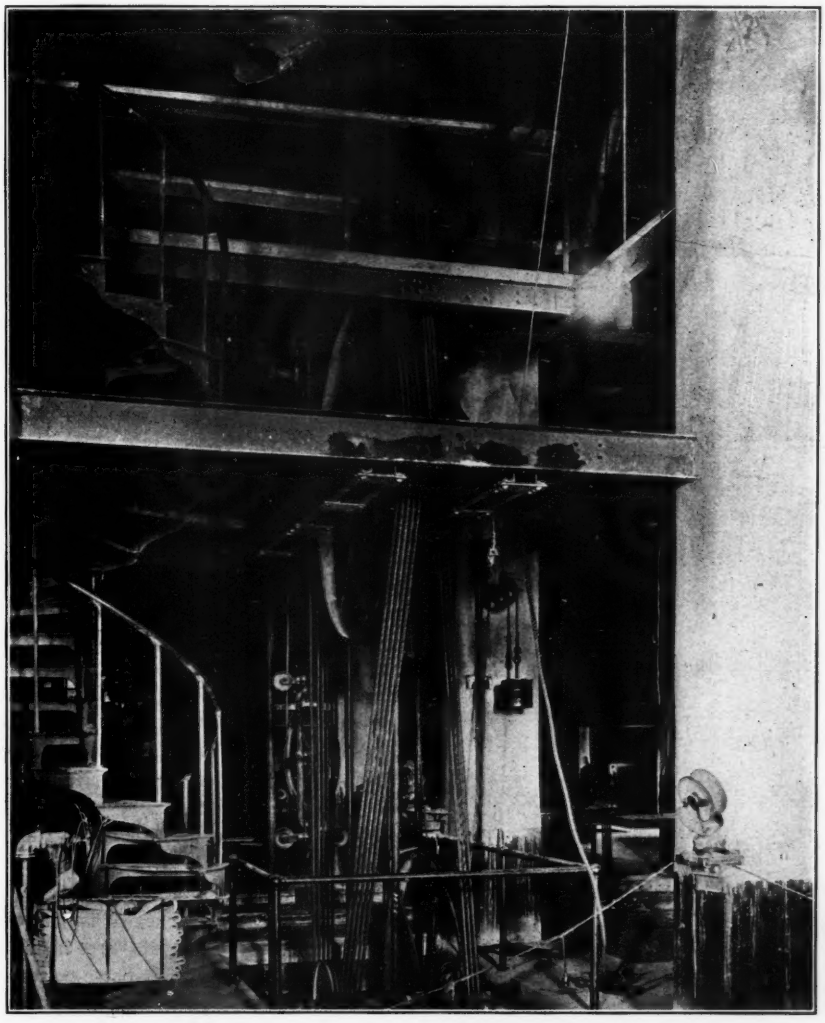


FIG. 2.—FORTY-HORSE-POWER INDUCTION MOTOR AND DRIVE FOR AUTOMATIC POWER SHOVEL AT WEEHAWKEN, N. J., GRAIN ELEVATOR.

This large number of bins is required to handle the variety of grains, of which there is a total of eighty-nine different grades that reach the New York market. There are twenty-four elevator legs, comprising eight for receiving, eight for shipping, seven for cleaning, and one for screening, and each grain leg has a capacity (in wheat, which is the heaviest of grains) of 10,000 bushels per hour.

The elevator is equipped with General Electric apparatus throughout, including motors, switchboard, cable, fixtures and lamps.

The motors aggregate nearly 3,200 horse-power, and are all General Electric form K, twenty-five-cycle, 550-volt motors of the dustproof type. Following is a description of the drives in order corresponding to the sequence of elevator operations.

The first use of power is for handling the freight cars that bring the greater part of the grain to the elevator. For pulling the cars into the building and disposing of them above the receiving hoppers, a forty-horse-power induction motor, having a capacity of twenty cars, is installed.

From the cars the grain is delivered to the receiving elevators by thirty-two automatic power shovels, sixteen for the east half and sixteen for the west half of the elevator. The shovels are driven by two forty-horse-power induction motors. The motor for operating the shovels for the east half of the elevator is installed in the centre of the building, supported on a platform twenty feet above the track floor, as shown in Fig. 2. This illustration and Fig. 5 give a good idea of the rope-drive connections to the motors with the pulleys for maintaining the tension of the drives.

The eight receiving elevators are operated by eight 100-horse-power induction motors installed in a line on the motor floor, as shown in Fig. 3. An output of seventy-eight horse-power is required to

elevate 10,000 bushels of wheat at the rate of 210 feet per hour.

Seven forty-horse-power induction motors are installed for operating seven compound-shake, double-receiving cleaners of 5,500 bushels capacity each, manufactured by the S. Howe Company, located on the ground floor and operated in conjunction with the cleaning elevators. The cleaners and dust-collecting system are supplied with air blast by a sixty-inch double sweeper fan, operated by the sixty-horse-power motor shown in Fig. 4, and located on garner floor, and by one fifty-five-inch and two sixty-inch fans operated by three forty-horse-power motors installed on the track or ground floor. The double sweeper fan forces air through the grain and carries the dust and dirt into cyclone collectors, from which it drops by gravity into the suction pipe of the fifty-five-inch and sixty-inch fans, which discharge it outside the building. This "compound dust-collecting system," as it is termed, is required for the reason that the air blast supplied by the double sweeper fan serves to collect the dust, but it is not sufficient of itself to carry the dust and dirt out of doors.

The cleaning elevators, seven in number, are identical in every way with the receiving elevators. They are operated by seven 100-horse-power induction motors and serve to bring the grain again to the top of the building. The next process is to drop the grain into scale hoppers for weighing. From the scale hoppers the grain is dropped either into freight cars or vessels for shipment, or into bins for storage.

FIG. 3.—EIGHT 100-HORSE-POWER INDUCTION MOTORS INSTALLED ON FIRST FLOOR OF CUPOLA FOR OPERATING RECEIVING ELEVATORS.

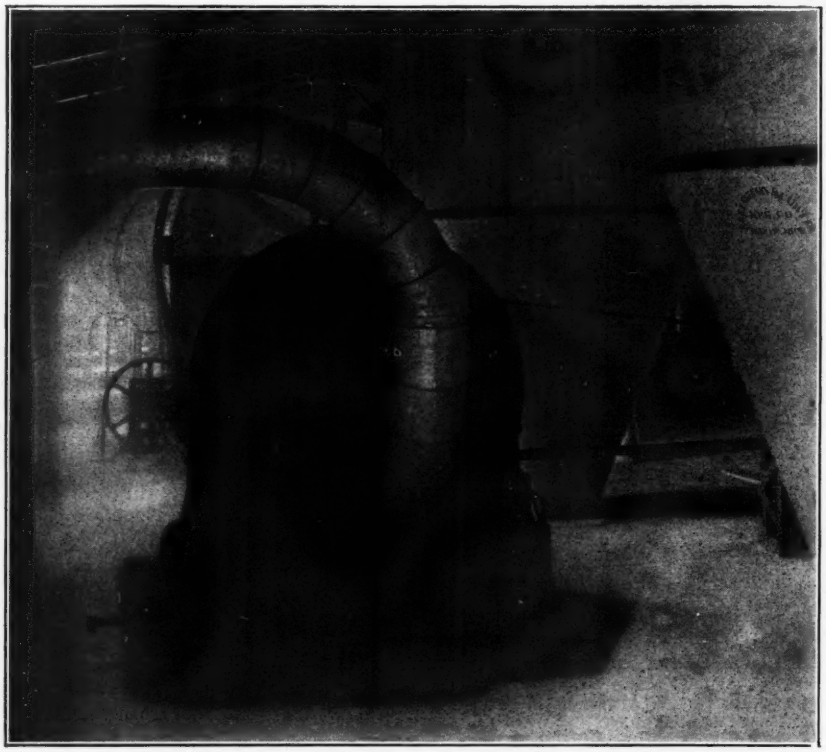


FIG. 4.—SEVENTY-FIVE-HORSE-POWER INDUCTION MOTOR DRIVING A SIXTY-INCH DOUBLE FAN, FOR COMPOUND DUST-COLLECTING SYSTEM.

For delivering grain from the storage bins to cars or vessels, eight shipping elevators are provided, each operated by a 100-horse-power induction motor. The grain descends through the building to the cars or vessels, by way of the scale hoppers for weighing, as above.

The marine elevator tower, operated by a forty-horse-power induction motor installed on the third floor of this tower, is for receiving the comparatively small amount of grain that arrives at the elevator by water. The capacity of the tower is 7,500 bushels per hour and it delivers its grain to either shipping or receiving elevators by the cross conveyors and longitudinal conveyors.

For carrying the grain from storage bins to shipping elevators, eight twenty-two-inch belt cross conveyors are installed, operated by the two forty-horse-power induction motors shown in Fig. 5.

For transferring the grain from one bin to another, or for delivering grain from a bin to a vessel, a longitudinal conveyor operated by a seventy-five-horse-power induction motor is installed. The thirty-six-

inch belt for this conveyor travels at the rate of 600 to 800 feet per minute, giving a capacity of 10,000 bushels per hour, and can be operated in either direction. This conveyor facilitates the delivery of the grain to the vessel, as it is often more convenient to convey the grain the entire length of the building rather than move the vessel itself.

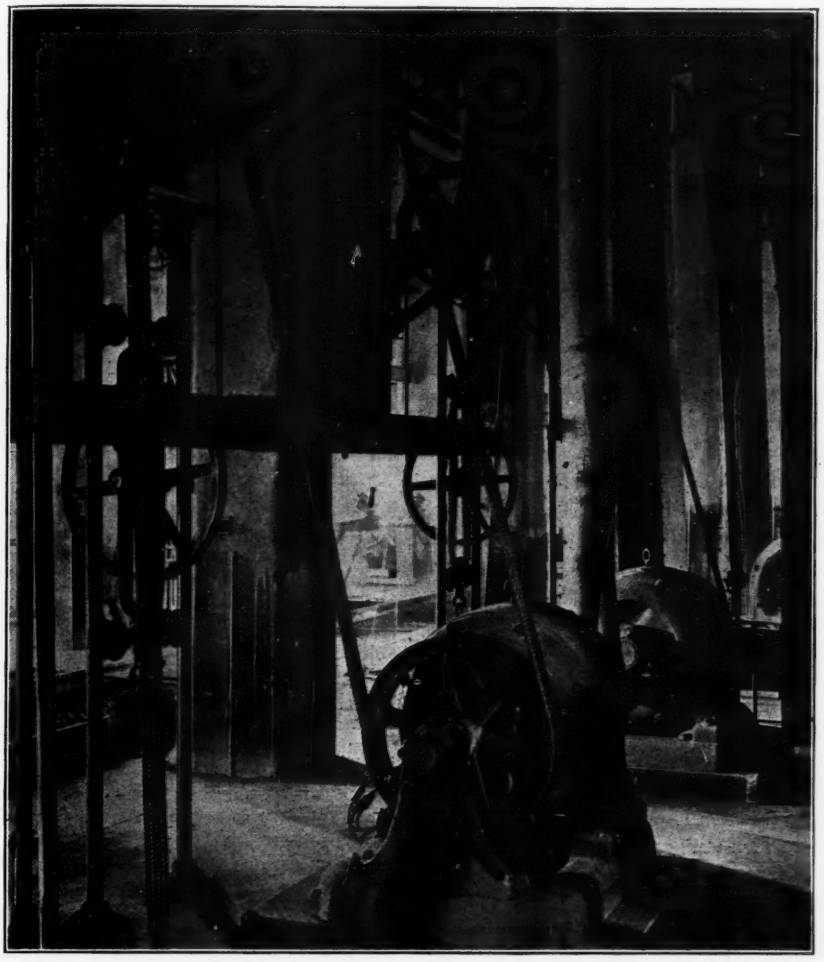


FIG. 5.—TWO FORTY-HORSE-POWER INDUCTION MOTORS AND DRIVES FOR CROSS-BELT CONVEYORS. EACH MOTOR DRIVES FOUR BELTS.

A forty-horse-power induction motor is installed on the motor floor for operating the screening elevator.

In addition to the above applications, a five-horse-power motor-driven automatically controlled Deane pump is provided for keeping the basement of the building dry. An additional equipment consisting of a Rumsey centrifugal pump, belt-connected to a ten-horse-power motor, is held ready for service as an auxiliary. There is also a ten-horse-power induction motor installed for operating a Morse & Williams passenger and freight elevator of one ton capacity.

The method of drive for all of the motors is by four-strand manila transmission rope manufactured by the Plymouth Cordage Company. There are five miles of the transmission rope installed, divided about equally between seven-eighths-inch and one-inch diameter.

The method of starting and stopping the motors is of unusual interest. All of the motors are started upon signals received at an annunciator placed in the switchboard room on the ground floor. To start any one of the motors an elevator attendant presses a button which signals the switchboard attendant to start the motor. To stop the motor, the elevator attendant presses another button, which trips an individual automatic oil-switch installed on the switchboard. Any of the motors may be started and stopped in this way either from the motor floor or from a point on the floor above.

Power is transmitted at 550 volts, three-phase, twenty-five cycles, through six paper-insulated, lead-covered, three-conductor, 300,000 circular mils cables laid in conduits from the generating station, which is in a separate building, to the switchboard room, on the ground floor of the elevator.

The switchboard room (Fig. 6) contains three receiving-panels, shown at the left, each equipped with three General Electric type F, form K, 550-volt, 1,000-ampere oil-switches on the incoming cables from the power station. On the risers from these switches may be seen the instrument transformers.

The main switchboard consists of fourteen blue Vermont marble panels each ninety inches high, including the twenty-eight-inch sub-base, comprising:

Eleven thirty-inch motor panels (nine of which appear in the illustration, Fig.

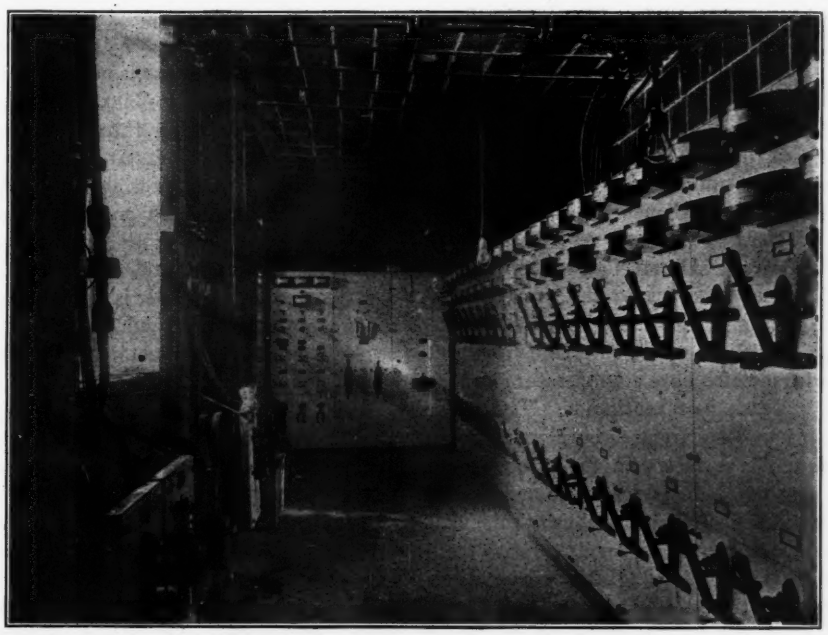


FIG. 6.—SWITCHBOARD ROOM ON GROUND FLOOR. THREE RECEIVING-PANELS AT THE LEFT. SWITCHBOARD AT BACK AND RIGHT.

6), each for controlling four motors. Each panel is equipped with four oil-switches having automatic trip coils mounted on the back of the panel, and with four horizontal edgewise ammeters.

Three thirty-two-inch panels are installed at right angles to the line of motor panels, as shown in the illustration. The left-hand panel, equipped with horizontal edgewise ammeters and switches, is for the general lighting distribution, and controls three thirty-kilowatt, 550-115-volt type H transformers. Two small 550-15-volt type H transformers, for supplying signaling current, are also controlled from this panel. The middle panel is equipped with a switch for controlling the circuits which supply electric heaters installed in several of the rooms of the elevator, and with two compensators for starting the motors. The right-hand panel is equipped with two sets of bus-bars and contains a double-throw compensator switch, by the use of which either compensator may be operated on either set of bus-bars. Each compensator is large enough to start four motors simultaneously, although in practice only one motor is started at a time.

The lighting of the elevator is by twenty-five-cycle current, using standard sixteen-candle-power, 115-volt incandescent lamps on flexible cord with individual ceiling cutouts. All wiring is in iron conduit. Outside lighting is accomplished by thirty-two-candle-power incandescent lamps mounted on iron goose-necks with waterproof hoods. Eight-candle-power incandescent lamps are used for signaling purposes.

ELECTRICAL NOTES FROM EUROPE.

(By Our Special Correspondent.)

It has been thought by different scientists that the curative effects of mineral springs are due in some cases to the presence of radium emanation, especially in the cases where chemical analysis does not show any special medicinal properties of the water. The recent researches of the Paris savant, Albert Nodon, seem to give additional proof as to the properties of the radium emanation. These tests were made with the water of the Dax hot springs, which have a temperature as high as sixty degrees centigrade. The water seems to come from a considerable depth below the surface. In the principal hot spring the water is very pure and is used for different hot-bath establishments, as it has a good reputation for its curative properties. According to M. Nodon's researches, these seem to be due to the presence of radium. Samples of the water are found to give off the radium emanation spontaneously and without interruption and give a negative charge which is quite analogous to the well-known effects of radium. The hot or cold water have the same effect, as well as the vapors which come off from the hot spring. In this way we may explain the curative effects of the spring. One practical point which results from these researches is that we may be able to reproduce these effects artificially by the use of radium, and to establish baths of this kind in the midst of a large city, so that they will be within the reach of all.

Monophase electric traction has been lately adopted on a line of some importance in Germany which runs from Ohlsdorf to Blankenese. The overhead trolley is used here and it takes 6,000 volts at twenty-five cycles. A new type of motor-car has been built for the road which has electric motors and the remainder of the outfit on the Allgemeine electric system. The motor-cars consist of two short cars placed end to end and coupled together. Each of the short cars is mounted at the outer end upon a bogie having two axles and at the inner end on a simple axle. This gives the complete or double car six axles in all, and it carries three single-phase motors of the Winter-Eichberg pattern, which is the new type adopted by the company. These motors are designed to give 115 horse-power and operate at 600 revolutions per minute. They use 750 volts at the terminals and twenty-five cycles. On the first bogie are mounted two such motors, each driving one of the axles. The third motor is placed on the second bogie, which also carries an air-compressor for the brakes. A set of transformers which is carried on the car is used to lower the tension from 6,000 to 300, 450 or 750 volts as required, using three secondary terminals. The 300-volt circuit is used for the lighting and heating, while the higher voltages are used on the motors. The car is equipped with three transformers in all, one for each of the motors. A relay-operated controller is worked from the motorman's cabin and gives all the needed connections of the circuits for five speeds of the train.

When fully equipped, the line is to use about fifty motor-cars of the above type. The first cars have already been completed and were put through a series of trials on a neighboring line, where they operated very well. The car is ninety-eight feet long and holds 260 passengers in all. The speed is from twenty to thirty miles an hour. An electric plant which is being erected at the Altona station will furnish the current for the new line. This plant has not been completed as yet, but is to contain steam-turbine sets consisting of Brown-Boveri turbines coupled to Siemens-Schuckert and Lahmeyer alternators.

A large hydraulic plant is soon to be erected in order to supply current for the Arlberg standard-gauge electric road, of which we expect to furnish some details later on. In the meantime we may mention that the new hydraulic station is to be located on the Inn river, near the Landech station. A fall of 230 feet is secured from the stream at this point and it affords a minimum output of 500 cubic feet per minute. It is estimated that the total capacity of the plant will be over 10,000 horse-power. The current will be used on the Arlberg road, principally between the stations of St. Anthony and Langen.

During the Milan Exposition, which is to be held this year, an important accident association, known as the Italian Industrial Society, whose object is to promote the use of improved devices for preventing accidents to workmen, has established a concourse of such apparatus; among these we may mention one for which a prize of 800 francs and a gold medal is to be awarded. This is a new apparatus which will give protection against accidents which may be due to bad connections in high-voltage transformers, and is to prevent any damage which may occur should the primary and secondary circuits of the transformer come in contact. Communications on this subject may be sent to the secretary of the society, 61 Torr Bonaparte, Milan.

C. L. DURAND.

Paris, March 3.

London Physical Society.

At the annual general meeting which took place at the Royal College of Science on Friday last, Professor Perry was elected president on the retirement, after one year of office, of Professor Poynting. The council and the other officers remain much the same, excepting that Professor Cassie, of Holloway College, has been elected secretary in succession to Dr. Watson, who has held this office for many years. After the elections Professor Perry, protesting vehemently against the custom of requiring presidential addresses, gave an address which dealt with the value of physics to engineers and with the proper methods of teaching this and other subjects to engineers. Professor Perry's views on these matters are very well known, of course. He would have it that a professor of science should be allowed to teach his students in his own way, and would have the examinations conducted and diplomas granted by each professor just as he liked. In connection with this last matter the audience greatly enjoyed Professor Perry's onslaughts on universities and all other constituted authorities whatsoever.—*Electrician (London), February* 16.

NOTES ON THE CONSTRUCTION AND MAINTENANCE OF OVERHEAD EQUIPMENT.[1]

BY ROBERT N. TWEEDY AND H. DUDGEON.

The tendency during recent years has been all in the direction of increased strength and, therefore, weight of poles, while it seems to us, at least, that the greater cost entailed is not warranted. For instance, a certain line was constructed under three contracts. One length of three miles is all span wire, and the poles are twenty-nine feet to twenty-nine feet six inches long, built up of three sections 6½ inches × 5½ inches × 4½ inches, out of steel one-half inch thick. Another equal length has poles 31 feet × 7½ inches × 6½ inches × 5½ inches × ½ inch for all straight-line work, whether span, side-bracket or centre-bracket construction; while the third contains centre, side bracket and span poles which are all taper 6½ inches × 4½ inches × ⅜ inch. Here we have poles of very different sizes doing the same work under the same conditions, and the smallest stand up just as straight as the others. All the sizes can not be right, and it is plain that the smallest is economically the best. Then the question arises, is the smallest small enough?

If engineers could persuade themselves that eighteen-inch sag in a thirty-foot span and two feet across a forty-foot road is neither unsightly nor detrimental, and would insist that the span wires are not pulled up any more than that, they would find the light poles which they have cast aside strong enough for seventy-five per cent of the construction, allowing heavier poles for curves and the like on twenty-five per cent of the line. In average ground with one-half yard or so of concrete round the pole, one inch to two inches is quite enough rake to allow when setting. For the average width of street the 500-pound (lateral strain for six-inch deflection) pole mentioned in connection with Bristol and Dublin is heavy enough for straight-line work if used in the proper manner. It is not unreasonable to estimate that a saving of $1,000 per route-mile can be made by following this advice. The height of all the standard poles is thirty-one feet, but there are many instances which will increase as the use of guard wires declines, where shorter poles would be as good. That is eminently the case in centre-pole and light bracket-arm work, where it is unnecessary to bury six feet of the pole, and, indeed, we have found a depth of five feet sufficient in straight-line span work of average weight.

When poles are subjected to less strain the quality of the concrete setting may be reduced. This costs at present about $2.25 per pole for labor and material, and it is usual to find that one bag of Portland cement is allowed per pole. This charge may be brought down to $1.25 or $1.50 with equal results, and, even with excessive tension on the span-wire, half a bag of cement has been found enough. Naturally, the materials for the poorer concrete must be good; the broken bricks, stone, slag or gravel, clean and wet; the sand sharp and clean, and the whole mixed thoroughly and allowed to set for a week or more.

Originally intended to protect gas and electric light standards, themselves of cast iron, the cast-iron base was retained by force of habit when steel tramway poles came into use. We suggest that from six to twenty tons of cast iron per average mile of tramway, serving no practical purpose whatever, is a luxury. But not only is the base no good, it is actually a negative good; it produces expense. It is usual to bury some inches in the ground, and to make a watertight joint at the top. Thereafter it is not moved, while underneath its well-painted exterior the most important section of the pole is being eaten away. An average base costs from $3.75 to $5, and weighs from 300 pounds to 450 pounds. If this luxury were relinquished it would make a difference of at least $225 per mile of route for bases alone, excluding materials and labor for caulking, and cost of extra labor and carriage entailed by their presence.

If bases are not to be given up, let them at least be drained and ventilated, and if possible let them be designed and erected so that they may be lifted out of the way, to allow the hidden part of the poles to be painted. It is better to steady and centralize the base with distance pieces cast on than to do any caulking, so leaving a passage for air and water. The water must be drained off, and that is facilitated if the concrete setting of the pole is raised in the shape of a cone above the surface of the road or path. With an annular space at the top and drainage at the bottom, there is a thoroughfare which will prevent or minimize sweating.

This question of ventilation applies with almost greater force to the poles. The necessity for ventilating such closed spaces is acknowledged by everyone who designs a feeder pillar. If the vents at the top and bottom or at the bottom only are stopped, the state of the switch panel and of the switch handles soon tells its tale. The question of sweating seems to require further investigation, for it is important even when the feeder cables are made of such materials and are treated in such a manner that damp will not affect them, as the poles are reduced gradually by oxidation. Suitable ventilation top and bottom ought to do much to overcome this trouble, and it would help matters to coat the interior of the pole with some paint or compound after manufacture. Experience gathered from various quarters seems to show that "side feeders" or "section cables" should be taken out of the pillar somewhere near the top, passing to the pole in a pipe at that level. Heavily taped and braided cables are better than lead-covered paper cables, and armoring is unnecessary and objectionable.

Another luxury, for which there is no more excuse than the base, and to which the objections are even stronger, is the cast-iron collar which conceals the joints in sectional poles. There are two per pole, costing from fifty cents to eighty cents each, averaging perhaps sixty cents. These run to $150 or so per average route-mile, and are worth saving on that account alone. Like the bases, these collars are rarely, if ever, lifted to paint the hidden parts of the pole, and few people know that they catch and hold rain. If they are examined, many are found to be broken. This follows on the entrapped water freezing. As many as eighty-two per cent of the collars on one stretch of line were found in this state. Lift them and a mass of rust is disclosed. The rust holds water like a sponge. If collars are to remain, it is important that they be drained, and that the parts of the pole beneath shall be painted as regularly as the remainder. The last vestige of utility would be taken from pole-collars if the swaged joints were finished taper instead of square, so forming a watershed as well as a pleasanter sight.

Section pillars may be set on damp courses with advantage, and the entrance of the cables should be well sealed. It is the practice of some contractors to fill the base of the pillar with bitumen, thus surrounding the cables whenever they leave through the bottom.

For the very reason that poles are too heavy, span wires tend in that direction also. High tensile strength and good galvanizing are greater considerations than any other, and 7/15 or 7/14 make strong enough spans for all but very heavy work. Under particularly bad conditions, as, for

[1] Abstract of a paper read before the Birmingham local section of the Institution of Electrical Engineers of Great Britain, February 14.

instance, near chemical works, special precautions have to be taken.

The steel wire attached to "pull-offs" should be tied firmly to the eyes, otherwise they become abraded in time, owing to the lift of the trolley poles. If thimbles are used, they take the wear and are satisfactory.

Guard wires should be tied in at every span to localize breakage, not tied merely to keep them in position relative to the trolley wires. Clamps to perform this duty are sold, and many are in use, but, for the reason which will be given when dealing with "hangers," they ought not to be made of gun metal. Much trouble from broken guard wires has resulted from this practice. If clamps are favored against the simple, cheaper and as effective binding-in, they should be made of malleable iron. It is permissible to insulate such portions of guard wires as lie above specially dangerous points, but proper attention to the overhead construction and the adoption of suitable retrieving trolleys ought to make that kind of thing unnecessary.

Other things being equal, gun metal is the nicest material for hangers. It is not liable to rust, and its constituents can be mixed in any proportion to suit the engineer, while it is considered an eminently safe metal when well made. Malleable iron, when made as it should be and as it can be made, is nearly as strong as gun metal, and is quite as safe in the sizes ordinarily used. Malleable iron goods must be well galvanized before use, and ought to be painted once every two years or so after the first three to five years, except in special circumstances. Economy without the sacrifice of safety can be obtained by the use of malleable iron fittings, and the saving per route-mile will be something like $40 if we assume 100 insulators per mile.

Malleable iron hangers have the advantage over those made of bronze that no local action occurs between the span wire and the hanger. This action has not received notice hitherto, but it is marked, and is the cause of serious weakening of the span wire. An excellent instance of this action has come under the direct observation of the authors. On the whole of one route five and one-half miles long the hangers are of bronze; on another route four miles in length, and a branch of the first, they are of galvanized malleable iron. While the span wires where they clasp the bronze hangers are practically eaten through and have broken in several cases, the galvanizing of the span wires under the malleable iron hangers and on the hangers themselves is as good as it was when put up. That is conclusive evidence against the decay of the first span wires being caused by rust. The same action occurs wherever the span wire is attached to secondary insulators in which the eyes are of brass.

Insulators divide themselves into two classes, primary and secondary. Of primary insulators, that most commonly used consists of an insulated bolt contained in a metallic waterproof casing, of which the composition has been discussed above. The insulated bolt is exposed from beneath to driven rain, to rain splashed from the trolley wire ear, and to water thrown during rain from passing trolley wheels, the last being the most serious, and, until recently, the most unexpected. Water thrown from trolley wheels contains conducting matter like copper dust from the trolley wire, brass dust from the trolley wheel, and graphite or oil from the trolley wheel bush or bearing; and it is to that extent at least undesirable, as it must deposit in time over the insulated surface of the bolt a conductive layer. But, apart from the deleterious action of the suspended matter, the water itself is injurious to the insulation. The failure of hanger bolts has been accepted as inevitable, and has been ascribed generally either to bad material or to climatic or local influences.

The first bolts were, and those most commonly used now are, of steel; comparatively lately the steel has been galvanized, and an alternative in the shape of a gun metal bolt has been introduced. In all cases the average radial thickness of insulation is three-sixteenths inch, while the length of leakage path runs from one inch to one and one-half inches. The reduction of this leakage path begins from the day of erection, and, sooner or later, depending in some unknown degree on local circumstances, every bolt must fail. First of all, moisture attacks the exposed end of the bolt, and a semi-conducting film is deposited over the whole insulating surface. That may take a year or two years, or in exceptional circumstances it may take no longer than six months. But the really dangerous action starts when the rust eats under the insulation from the exposed end. Gradually and gradually that process goes on until the cylinder of compressed insulation begins to swell and to crack under the pressure of the increased volume beneath it, and at length there is no effective insulation at all except the three-sixteenths-inch radial thickness between the bolt and the hanger casing. A little more and that is bridged, with, perhaps, disastrous result. To galvanize the bolt but lengthens the period over which this cycle takes place; it does not stop it. But electrolysis is the main factor concerned in the destruction of both iron and brass bolts, although at first sight plain oxidation seems to be enough to account for the failure of the iron bolts, as explained above, and we will leave them for the time in order to consider the history of the brass bolt. Imagine slight leakage occurring over the insulated surface. In the presence of an electrolyte supplied by the trolley wheels, if by nothing else, particles of brass are carried down the stream and become deposited by degrees over the whole surface, leading finally to failure of the insulation. In the case of the iron bolts the same thing happens, but the deposit of pure iron is oxidized almost immediately and does not afford a good path.

A length of five miles was equipped with brass bolts; another of four miles, in a much less pure atmosphere, but within the same ten-mile circle, had iron bolts. Neither was backed by secondary insulation, except such as might be afforded by sleeves of fibre. During heavy and continuous rain it was always the former line from which came reports of "live poles," although many of the iron bolts had the appearance of being useless as insulators from the way in which the coating was split. It was a noticeable fact that brass bolts lasted for a shorter time, and failed even more suddenly than iron bolts because they give so little visible notice of their intention.

There are three ways in which these troublesome and expensive failures may be prevented or alleviated. First of all, we believe that entire prevention can be obtained by the insertion of a shield between the trolley wire ear and the hanger, in order to keep the bolt dry. The trolley wheels can not then throw water into the interior of the hanger, and neither rust nor electrolysis can corrupt; secondly, the form of the hanger may be altered, making it nothing more than a metallic link between the ear and the span wire, and providing for insulation by means of two (three per span) external and independent insulators; lastly, the hanger may be composed of homogeneous insulation, such as glazed porcelain, something in the shape of a cable sealing-end, through the centre of which a plain metal bolt is passed. Whatever form the primary insulator takes it must be kept dry, or leakage and carriage of metal will start. Therefore, this porcelain insulator should be provided with a hood of some light material to guard it against rain, and with the shield men-

tioned above to prevent access of moisture from the trolley wheels.

The secondary insulators in most general use are of three kinds, known respectively as "Brooklyn strains," "turnbuckles" and "globe strains," with a fourth, the porcelain reel, coming into favor. The first two are adjustable. No English linesman wants such devices during the erection of a line, and after this is once done there is still less necessity for them. Nevertheless, both types have been used by thousands, and the illustrations of new lines which appear in technical journals clearly show that their use continues almost unabated. It is an axiom that adjustable insulators are not required anywhere on the overhead equipment of a tramway.

Of the other type, that is to be preferred which is the most homogeneous, and has least parts of any kind, and of metal in particular, while giving at least equal results in other ways. On every account the porcelain reel is the one to use. Born under adverse conditions, this insulator has withstood the unclean atmosphere of the black country and of the potteries with remarkable success, and in the larger form shown here it need fear no more expensive competitors.

Obviously leakage can not take place across the primary insulator without the consent of the secondary, but luckily the converse is equally true, so that our main efforts should be given to rendering the primary leakage impossible, and the secondary will take care of itself.

That end of a "Brooklyn" or a "turnbuckle" or a "globe" which was attached to the pole—the negative side of that part of the circuit—can be identified by the collection of copper sulphate which has formed close up to the insulation. In the same way the zinc first and the steel next of the span wire where it encircles the reel insulators falls a prey to the action, and gradually changes into a mass of oxide. So marked is this phenomenon after several years that a linesman may save himself time, and his employers money, by inspecting the secondary insulation first. If there is no deposit there is no leak, and the primary insulation is good, and vice versa. As a matter of fact, we do not recommend this method of testing for everybody.

Until quite recently the general practice has been to use circular trolley wire fastened to the supports by sweated ears. The ears have been either deep or shallow grooved, the former encircling the wire almost completely and the latter only in part. Very few have refused to recognize that circular wire suspended in this way is unsatisfactory, but the fault lies with the ears and not with the wire. Many attempts have been made to overcome this difficulty with mechanical ears of various kinds, but without full success. The only problem involved is to provide an absolutely smooth and unbroken path for the trolley wheel. If there is any change of section or gap in that path the wheel must jump, with the result that when no current is passing to the car the effect is identical with the effect of car wheels at the joints of rails, and that when current is passing a more or less destructive arc is formed. This trouble is the direct cause of the substitution of flexible suspensions for rigid suspensions on bracket arms, for double insulation could be managed without the "bow-string." So long as the trolley wheel runs with perfect smoothness, flexible suspensions have no particular advantage over rigid suspensions, if the trolley wire is at taut as it ought to be. In fact, we suggest to this audience that economies may be made in this direction now that figure 8 and grooved wire have come into fashion.

There is no doubt of the efficacy of 8 wire in supplying the desideratum mentioned above, but the grooved section hardly does this, as the ears can not be made to clear the trolley wheels. Nevertheless, the use of 8 wire is not extending in any marked degree. Two well-known firms of wire-drawers replied to an enquiry as to the ratio of 8 and grooved wire to circular supplied by them in the following terms: (1) "We can not say exactly, but the proportion of figure 8 is very small, and we have been informed that this is being practically discarded in America, where it was very much used a few years ago." (2) "The present ratio of demand for grooved is about ten per cent of the round, while figure 8 has practically ceased to be used according to our experience." These makers state that the extra cost of grooved and 8 wire (weight for weight) is from $11.75 to $15 per ton, but a large user of 8 wire writes that "there is no difference in the cost of wire, makers quoting us the same price per pound for each type." In any event, the difference in price is almost negligible, and might become so altogether if either section were used to the same extent that circular wire is now.

Then with regard to erection, a correspondent who has designed a complete line of fittings for both grooved and 8 wires, and has supplied large quantities of both, but has not carried out the erection, says: "the first cost of the fitting for the grooved wire is slightly more than the round, but not so much as in figure 8. It is very easily adjusted when up, and the wear on the fittings is practically nil. The wear of the wire is less than in the sweating system, as there is practically no under-running, and there is not the objection of having heated wire as in the sweating. . . . The objection to figure 8 wire is that it is more difficult to erect than the grooved wire, and more expensive in fittings, and in requiring more experienced men to fix it, but when properly fixed makes a very satisfactory job." On the other hand, the user quoted above on price says that "there is no greater difficulty in erecting figure 8 than circular wire of similar sectional area, contractor's price for two recent contracts being the same per 100 yards for both. . . . One section . . . we have had working has given us no difficulty or trouble of any description," and he adds: ". . . in my opinion figure 8 is much better than grooved, one of the chief reasons being that the top lobe of the figure 8 allows a much better grip for ears than grooved wire, also the bottom lobe, if you used, say, 2/0 section, can be made so that the contact area to the trolley wheel is equivalent to 4/0 circular."

The fact has to be faced that circular wire with the present forms of ear means continual expenditure for repairs and an unpleasant feeling that too much depends on the linesmen. Under these conditions there are nearly 100 potentially weak points in every mile.

Out of the forty-seven corporation tramways which answered Mr. McElroy's question as to the size of wire in use in 1904, fourteen use 1/0, four use 2/0, fifteen use 3/0, and seventeen use 4/0 S. W. G. circular wire, these including three tramways on which two sections are in use. In a few cases there is some difficulty in determining from the printed replies whether the sizes are given in B. & S. or S. W. gauge, and in view of the difference between the two clear distinction is desirable. It is evident that the tendency in 1904 was toward heavier sections than the 1/0, which was almost a standard for several years, and during the interval that tendency has become more strongly marked. In face of such a definite expression of opinion it will seem rashness on our part to suggest that the factors which have led to this radical change are not sufficiently clear.

Mr. Sayers said, in his paper before the Tramways and Light Railways Association, "that there is no electrical necessity for using any wire larger than No. 0 S. W. G. . . . unless the traffic is extremely heavy," and in certain other special cases,

as on curves of short radius. The average density of traffic is not what Mr. Sayers means by "extremely heavy," nor is it likely to become so. The necessity for heavy wire on the electrical count being removed, the mechanical count alone remains, and on this point every engineer has his own opinion, as it does not lend itself so readily to exact demonstrations. Our opinion is that an equivalent section to 2/0 circular wire is the maximum required by the average tramway.

There is a real need for larger contact area between trolley wheel and wire than is possible with 1/0 or even 2/0 circular wire, and it may be that this need has helped engineers toward the use of 3/0 and 4/0 circular wire, but the same effect can be obtained in a cheaper way by rolling 1/0 or 2/0 wire to a flattened curve on the underside. Whether that is done with circular, 8, or grooved wire must rest with the individual engineers, and probably figure 8 and grooved wires are not feasible in such a size as 1/0. We are the more insistent on the subject of returning to smaller sizes because the figures of wear which we have secured show clearly that, points of suspension apart, No. 0 S. W. G. has a useful life which meets all present requirements.

Trolley wire wears from four causes: (1) rolling friction due to trolley wheels; (2) sliding friction due to trolley wheels in fixed heads on curves and badly aligned wire; (3) arcing due to high-current density; (4) impure atmosphere.

Although circumstances have prevented the figures being complete, and although much remains to be done in this way by other and more competent observers, we think that the general statement above is fairly well borne out, and that there is some positive foundation for our conclusions:

(1) That the depreciation due to rolling friction is almost negligible; (2) that sliding friction may be reduced to the same negligible quantity by attention to alignment and by the universal use of swivel trolley heads of the freest type; (3) that arcing is the most serious trouble of all, and must be discounted by the use of modified trolley wire section and a complementary trolley wheel; (4) that the effect of an impure atmosphere requires further elucidation; (5) that the method of suspension does not affect the wear, and (6) that the effects of (*a*) height of wire and (*b*) pressure of trolley wheel require careful examination.

LETTERS TO THE EDITOR.

Electrical Measuring Instruments—A Comparison of English and American Practice.

To the Editor of the Electrical Review:

I have read with considerable interest several articles which give an account of English practice in the matter of electrical measuring instruments.

There seems to be considerable discussion going on in England at present on this subject and several papers relating thereto have been presented before the Institution of Electrical Engineers. These papers impress such of us as are engaged in the manufacture of electrical measuring instruments, or have occasion to employ them in practical commercial instruments, as being curiously out-of-date. It may be that instruments constructed on what we consider scientific principles and made in a mechanical fashion are in use in England, but if so they are seldom mentioned or described in printed articles. I have in mind two articles which have been reprinted in our American journals recently, one by Kenelm Edgcumbe, entitled "Some Recent Electrical Measuring Instruments," which is an abstract of a paper read before the Junior Institute of Engineers in London, February 2.

Mr. Edgcumbe first discusses the desirability of installing an ammeter with each motor in order that there may be a visible indication of the work done by the motor and a ready means to determine when the motor is overloaded. For this purpose he suggests either an ammeter calibrated in amperes or an ammeter calibrated in horsepower for any given voltage. The use of an ammeter is a very simple proposition and is sufficient for ordinary cases. Where it is desirable to show the total horsepower, I think it is preferable to use a wattmeter, so that true, rather than approximate, readings may be obtained. The object to be attained is the prevention of overloading, and an overload may quite as well be due to excessive voltage as to excessive current. The ammeter would indicate only one of these factors while the wattmeter takes cognizance of both.

Mr. Edgcumbe wisely advocates the use of an instrument case which will protect the instrument from rough usage and likewise from the dust and dirt liable to be found in a machine shop or mill. This practice is almost universal in our country, the instrument system being enclosed in an iron case which naturally protects it as well as shields it from external magnetism. Personally, I advocate having the instrument case finished in black enamel rather than in nickel or copper plate. The instrument can be kept clean and presentable much more readily.

Apparently, Mr. Edgcumbe is not familiar with anything more modern than the soft-iron instrument. This is a type which has practically been abandoned in this country in favor of the d'Arsonval system for direct current. The d'Arsonval system can be made as strong and rugged as any soft-iron instrument and possesses the advantage that it is not necessary to damp it by means of an air-vane. Furthermore, no allowance need be made for errors of lag or hysteresis. I judge from Mr. Edgcumbe's article that they are still using what we term two-vane soft-iron instruments, many of which are mounted in spun-brass cases, damped by means of a piston traveling in a cylinder. All such construction is obsolete with us, the two-vane form of soft-iron instrument having been abandoned many years ago on account of the impossibility of eliminating errors due to residual magnetism in the two iron vanes.

In alternating-current work, Mr. Edgcumbe advises the use of a wattmeter which is in accordance with American practice. He seems to think, however, that the wattmeter must necessarily contain iron in order to ensure mechanical strength. We have demonstrated in our practice in this country for many years past that the presence of iron is totally unnecessary, and by eliminating it we eliminate the errors which naturally follow as the result of its use.

Mr. Edgcumbe also discusses frequency indicators of various systems, none of which would appeal to the American engineer, being apparently ignorant of the fact that a perfectly accurate and reliable frequency indicator can be constructed on the dynamometer principle and subject to none of the errors he describes.

Following this article, I find in the Electrical Review of February 24 an abstract of a paper by W. E. Sumpner, entitled "Iron-Cored Alternate-Current Instruments." This paper was presented before the Institution of Electrical Engineers, and in its original form apparently contained an elaborate mathematical proof of the statements given in abstract by the author.

Mr. Sumpner first condemns induction or eddy-current types of instruments. In this I thoroughly agree with him. He then proceeds to describe his substitute, in which I do not agree with him at all. Apparently, Mr. Sumpner is deeply impressed by the advantages of the d'Arsonval type of instrument, now almost uni-

versally used in this country for direct-current measurements, and has endeavored to apply an instrument of this type to alternating-current measurements. In place of the permanent magnet field employed in the d'Arsonval instruments, he proposes an electromagnet field which is excited by the current to be measured, the core, of course, being laminated. Mr. Sumpner then proceeds to demonstrate that there are errors of considerable magnitude introduced into instruments of this type, but endeavors to show that, by proper design and allowance, these errors are not very serious. That errors are present and must be present he acknowledges and endeavors to obtain a general compromise between the errors due to self-induction, hysteresis, leakage and phase displacement.

It would seem to me that Mr. Sumpner has gone to a great deal of trouble to design an instrument in which errors are inherent when he had at hand instruments in which all of these errors are eliminated.

For accurate alternating-current measurements we are accustomed to the use of instruments constructed on the principle of the electrodynamometer in which no iron is present, consequently, we have no such fundamental errors to allow for. I can not see why anyone should desire an electromagnetic form of d'Arsonval instrument which possesses no advantage over the dynamometer type and does possess very many disadvantages which are not inherent in the dynamometer. It may be that the dynamometer type of instrument is not known in England, but, if not, it would seem as though it would be profitable for some English engineer to visit this country long enough to observe the results we have been obtaining with this type of instrument for many years past. It is standard practice with us to use the dynamometer type voltmeter and wattmeter, and it is perfectly possible to employ the dynamometer system in an ammeter under certain conditions.

Considering the type of dynamometer voltmeters and wattmeters made by my company, with which I am most familiar, the actual error, due to self-induction, in a voltmeter of 150 volts range is .018 per cent (less than one-fiftieth of one per cent) for 133 cycles when the instrument is calibrated on direct current. In a wattmeter for use on 150-volt circuits, the error is .00013 per cent for 133 cycles. As is well understood this error decreases with an increase in voltage, range or a decrease in frequency. Mr. Sumpner seems to be very well satisfied with a wattmeter error of one per cent when used on a circuit of power-factor of 0.70. I have determined the error of a dynamometer type wattmeter, of the design made by my company, as 0.118 per cent for a power-factor of 0.766; the wattmeter having been calibrated at unity power-factor.

J. FRANKLIN STEVENS.

Chemistry in Engineering.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I have read with considerable interest, though somewhat late perhaps, your editorial on "Chemistry in Engineering," and I beg to express my appreciation of the suggestion therein contained and to express my hope that you will go still further into this most prolific field.

I have had a somewhat wide experience in the application of chemical law to electrical engineering and I regret to testify that the ignorance which I have found among designers and builders of electrical apparatus is as universal as it is profound.

It is a matter of regret that the intelligent application of chemical science which has played so important a part in the most recent electrical development should be entirely neglected in the more fully developed and established electrical industries.

In other words, it is too bad that the aid which chemistry has given in research work, in experimental and theoretical directions, should be wholly and utterly neglected and that no application whatever of chemical law should be made to motor and dynamo construction.

So gross has this neglect been and so great is the ignorance with which machines have been crippled through inattention to the chemistry of the subject that very few machines are in actual service to-day which are giving anything like the efficiency which they could develop if insulated according to chemical law.

Recently I had occasion to examine a generator which had been giving very poor service for something like five years past, requiring a new commutator every year and requiring constant "patching up."

When the armature bars were removed it was found they had been "insulated" by wrapping them with oiled linen and that the acids of which the oil was composed had attacked the copper, seriously diminishing the sectional area and impregnating the linen itself with a copper salt of very low resistance (and which undoubtedly was highly conductive at the time of its formation).

Examining into the matter further I found the commutator segments had been insulated with little sheets of mica, really scrap, pasted together with shellac varnish, or an equally acid mixture of copal, and that the same deleterious chemical action had taken place there.

I was informed by the superintendent of the plant that in his opinion the breakdown, delays and losses caused by the poor insulation of this machine amounted to more than the original cost of the machine itself ($2,000).

This machine's service had been less than five years. It is needless to say that the machine is now being thoroughly reconstructed and that in its reinsulation due regard has been given to every law of chemistry which bears upon the matter.

It is an interesting coincidence that the factory in which that machine was built and insulated was sold at auction a few days since, indicating that the same neglect which had perpetrated such an unnecessary loss upon the buyer of their machine had permeated the other departments of that company and had evidently led to financial disaster.

Chemists are cheap; young men thoroughly grounded in the principles of science can be secured at wages approximating machinists' apprentices until they are given an opportunity to demonstrate what they can earn for electrical interests in establishing practical economies.

CHAS. E. FARRINGTON.

Walpole, Mass., March 12.

Canadian Electric Railways.

According to the official Canadian report on the subject of electric railways, there were 793 miles of electric roads in Canada on June 30, 1905. The increase during the year was thirty-six miles. The total paid-up capital of all the companies was $61,033,321. The consolidated income account of all of the electric roads of Canada for the year ending June 30, 1905, shows the gross earnings to be $9,357,125, an increase of $903,516. The operating expenses were $5,918,194, an increase of $591,667. The net earnings were $3,438,931, an increase of $311,839.

The number of passengers carried by all the electric roads during the year was 203,467,317, an increase of 22,777,319. The freight carried amounted to 510,350 tons, showing an increase of 110,189 tons.

The total car mileage of the roads for the year was 45,959,101, an increase of 3,982,977 miles.

Fifty-six people were killed by the street railways and 1,269 were injured.

Transforming and Distributing Substation at Montreal, Canada.

By J. A. Burnett.

FOR some time past the problem of economical distribution of power in cities of a quarter of a million and upward of population has received attention. It was once thought that one central station, with feeders running to centres of distribution and all switching apparatus concentrated within four walls, was the natural tendency.

Latterly, it has been considered preferable to build receiving stations at suitable points, send power at, say, 11,000 volts, three-phase underground, and to distribute from these stations at 2,400 volts three-phase or single-phase overhead. The expense of attendants, interest, etc., when capitalized, has been estimated to be much less than the outlay on ducts, feeders at 2,400 volts and the value of energy loss as would be necessitated by the first scheme outlined.

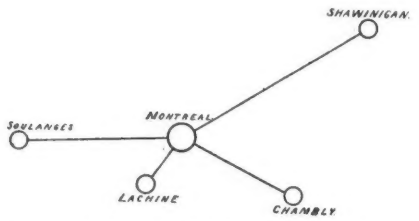


FIG. 1.—SOURCES OF POWER, MONTREAL LIGHT, HEAT AND POWER COMPANY.

The city of Montreal, whose electrical needs are supplied by the Montreal Light, Heat and Power Company, has rather unusual conditions to satisfy. Power is sent in from four sources, as shown in Fig. 1. These summarize as follows:

	Miles.	Kw.
Shawinigan Falls.....	85	9,000
Chambly.....	15	15,000
Lachine	5	9,000
Soulanges	30	12,000
Steam reserve.....	$\frac{1}{10}$	4,000
		49,000

The latter development, Soulanges, is under construction.

The Montreal Light, Heat and Power Company operates six stations grouped, as shown in Fig. 2. These seven stations are all interconnected by tie-lines—the uniform voltage of 11,000 being employed. The general consolidation of the immense properties of the power company in Montreal, aggregating, as shown in the above list, some 49,000 kilowatts of load, is being brought about under the supervision of Mr. R. S. Kelsch, consulting engineer of the company, and the station here described is merely one of a series being planned to bring about this consolidation.

Between the Shawinigan power station, Orleans avenue and the central station is situated the Mentana street station, distant about 16,000 feet from each. This station may be fed from the Shawinigan station or the central station or by both. The tie-lines are looped in and either tie-line may be opened at will. This is shown on Fig. 3, which also shows the general scheme of connecting up apparatus in the station.

As the voltage on the tie-line may vary between considerable limits, owing to the effects of load at either receiving station, it is necessary to use an induction regulation, so that voltage on the substation buses may be regulated at will. Put into other words, the tie-line voltage may be dropping and at the same time it may be necessary to raise the substation bus-bar voltage in order to compensate for distributing feeder drop.

It may be well, at this point, to describe the building itself: this is of concrete, proportions one sand, three cement, five broken one-inch stone, internal dimensions sixty feet square and thirty-five feet from ground line to roof. A commodious basement with nine feet head room is provided, reached by an iron stairway. Wood was eliminated as much as possible, only the main sliding door and porch door being of this material. The sliding door is of the Underwriter's pattern and covered with sheet metal. Windows are of copper frames and fitted with one-quarter-inch wired glass, as is also the large roof monitor or skylight. The roof, it will be noted (Fig. 4), drains to the centre where, a down soil pipe runs to the sewer.

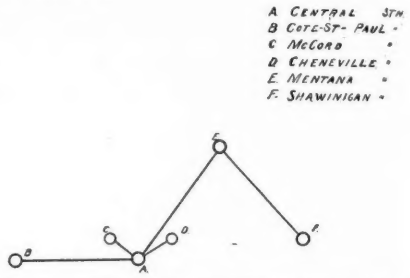


FIG. 2.—SUBSTATIONS, MONTREAL LIGHT, HEAT AND POWER COMPANY.

The walls contain two and one-quarter-inch vitrified clay duct from basement to point of exit, and each 2,400-volt feeder cable is thus isolated. This is a valuable feature in case of a cable breakdown.

MENTANA STREET SUBSTATION, MONTREAL LIGHT, HEAT AND POWER COMPANY.

A fifteen-ton hand crane is provided for handling transformers, blowers and regulator, and for lifting apparatus out of the basement. Two iron-covered hatchways are provided under the crane area to give access to the basement, the heavy

covers being themselves handled by the crane.

The interior walls were all plastered white and, with the liberal number of windows employed, as well as the light from the roof, the station has a well lighted and pleasing effect at all times. The main floor is five inches thick and contains a network of one and one-quarter-inch wrought-iron cement-lined conduit for control wires, something like 2,000 feet being used for this purpose. The illustration (Fig. 7) shows those used for connecting up arc apparatus. Careful attention was given to enclose all current carrying cables in clay duct. Crosses were avoided in open cable work, but were done instead where cables were buried and consequently isolated from each other. The station contains seventeen 1,000-kilowatt, alternating-current, three-phase, 2,400-volt feed switching units, panels, etc., and twenty fifty-light alternating-current arc transformers and constant-current regulators and 2,000/4,000-volt transformers.

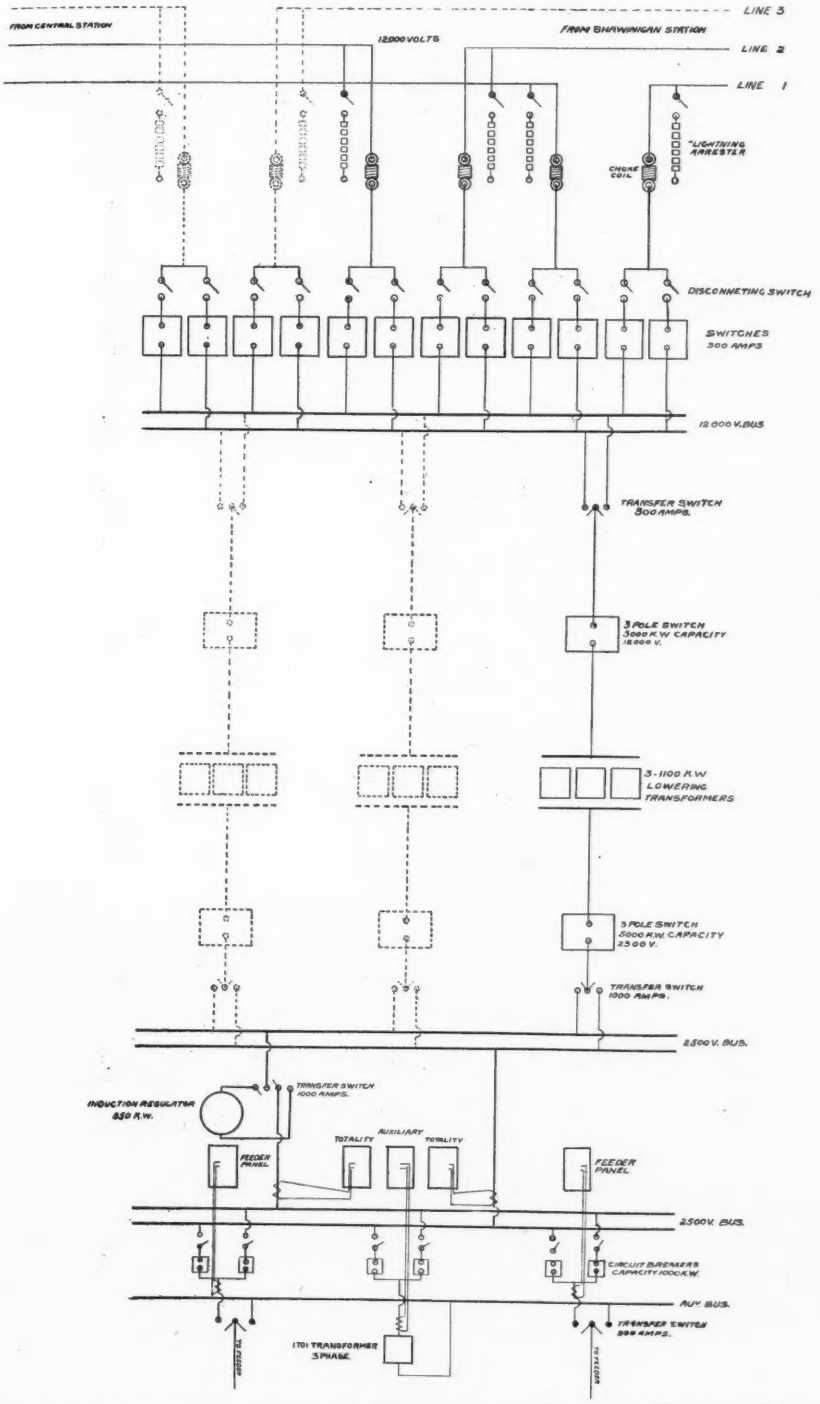


FIG. 3.—DIAGRAM OF LINE CONNECTIONS, MENTANA STREET SUBSTATION, MONTREAL LIGHT, HEAT AND POWER COMPANY.

A reference to the diagram of connections (Fig. 3) shows that the circuits, three incoming and three outgoing, come into the station through the lightning protection apparatus, thence to knife disconnecting switches and thence to solenoid operated General Electric type form "F-K" oil switches, from these to knife disconnecting switches and to a double set of concrete enclosed 11,000-volt bus-bars. These bars are also sectionally divided, making it possible to operate different sections of station load from two distinct and separate sources of power.

From these bus-bars leads are carried to an automatic type H-3 General Electric oil switch, 300 amperes, 13,000 volts rating, thence through current transformers to an open wiring transformer delta connection for primary grouping, indicated on Fig. 5. The lowering transformers consist of three banks of three each, 1,100-kilowatt air blast, General Electric make. The primary windings are adapted for 9,700, 10,300, 11,000 or 12,100 volts, with taps to obtain either two-phase or three-phase on the secondary winding at 12,100-volt primary. The secondary winding is adapted for either 2,300 or 2,400 volts. The leads are brought up through the base and once in the air chamber, are brought to the clay ducts as quickly as possible. This is shown on Fig. 4.

Owing to the standard spacing of transformers bringing these large units into such close proximity, it has been found by practical experience that in the event of a transformer breakdown and resulting arcing, the flames are carried by the air blast into the neighboring transformers, resulting in their destruction. To obviate this unsatisfactory result, a cast-iron sub-base or damper was devised. This stands six inches high and coincides with the base outline of the transformer. A substantial grid or valve, not unlike that used for steam, was devised, and with a horizontal movement of about three inches the air is instantly cut off. Balanced or butterfly valves have been experimented with, but found unreliable. With the valve above, as adopted, a quick pull on a hand lever completely isolates a defective air-blast transformer. The working faces are, of course, machined and tested for air leaks before acceptance. The transformer leads are carried through one side of this sub-base by means of closely fitting bushings. The operating handle is shown in the elevation of the transformer,

Fig. 4. The upper part of the transformer is provided with pivot knife blade switches to obtain the different primary winding

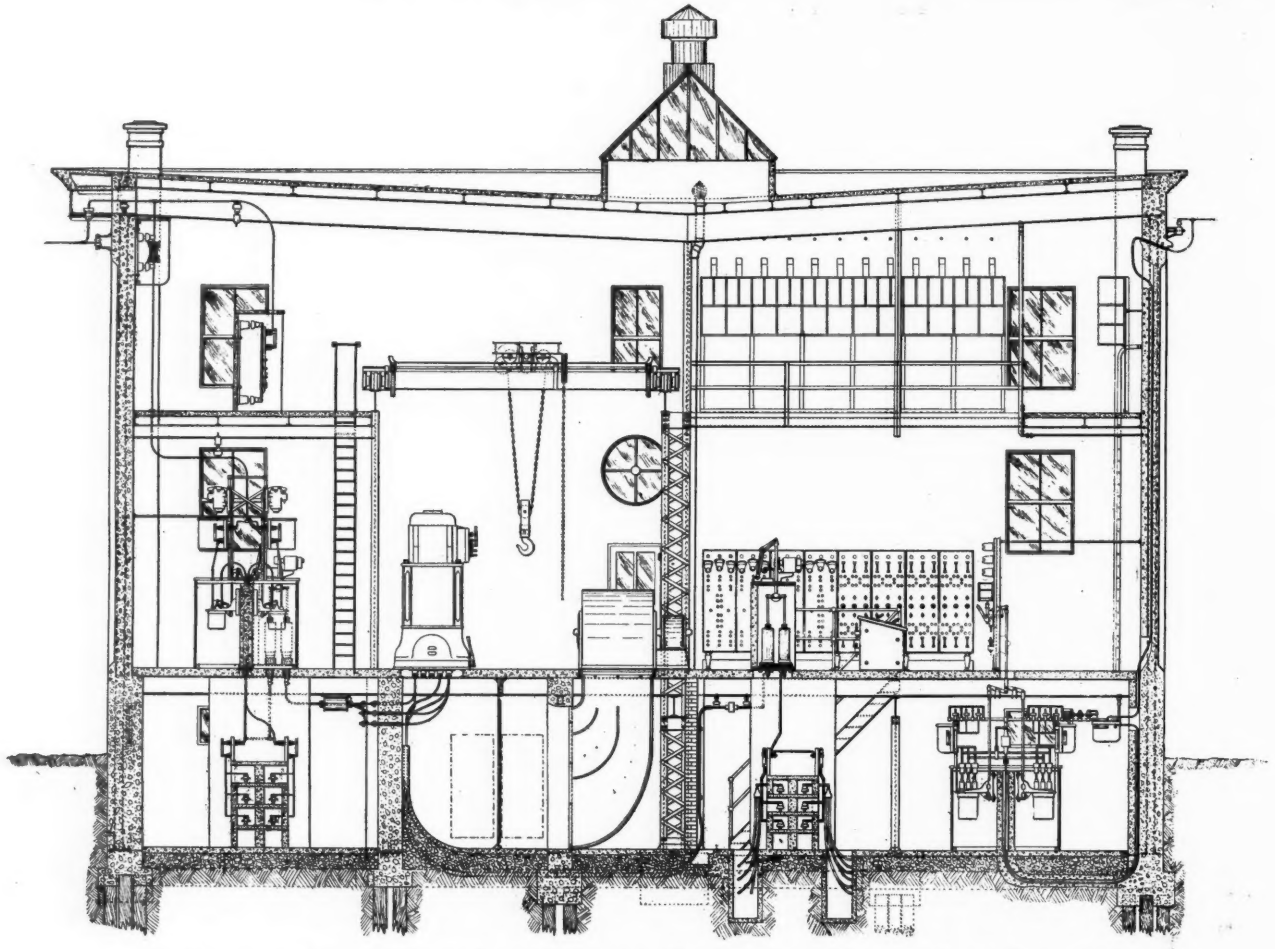


FIG. 4.—ELEVATION, MENTANA STREET SUBSTATION, MONTREAL LIGHT, HEAT AND POWER COMPANY.

combinations, before mentioned. These transformers have a floor space of four feet five inches square and are eight feet nine inches in height, and in weight run about 18,500 pounds. The air required for cooling purposes runs about 2,700 cubic feet per minute at three-quarters-ounce pressure. Motor-driven fan sets for cooling transformers are provided three in number, each driven by a seven and one-half-horse-power, alternating-current, 110-volt motor. These are compact and require little attention. The fan is a sixty-inch disc and runs at 600 revolutions per minute.

The air is blown down through the main floor and into the air chamber. This is a spacious room, being eight feet six inches wide, nine feet high and fifty-one feet long. An air screen is shown in the section and consists of a series of screens of one-half-inch round iron frames, covered with No. 10 wire mesh three-inch centres. Over this is placed a layer of cheese cloth with edges stitched on the one-half-inch iron frame. This is renewed periodically and accumulated dirt removed. The cheese cloth—to a certain extent—cuts down the air head or pressure. This is offset as much as possible by a large ratio of screen to fan opening area. In this case the screen area is approximately 460 square feet, whereas the fan outlet area is 22¼ inches by 50½ inches, giving 33.6 square feet for the three fan sets. Ordinarily two fan sets will furnish enough air for the nine lowering transformers and the induction regulator, which is also of the air-blast type, so that the

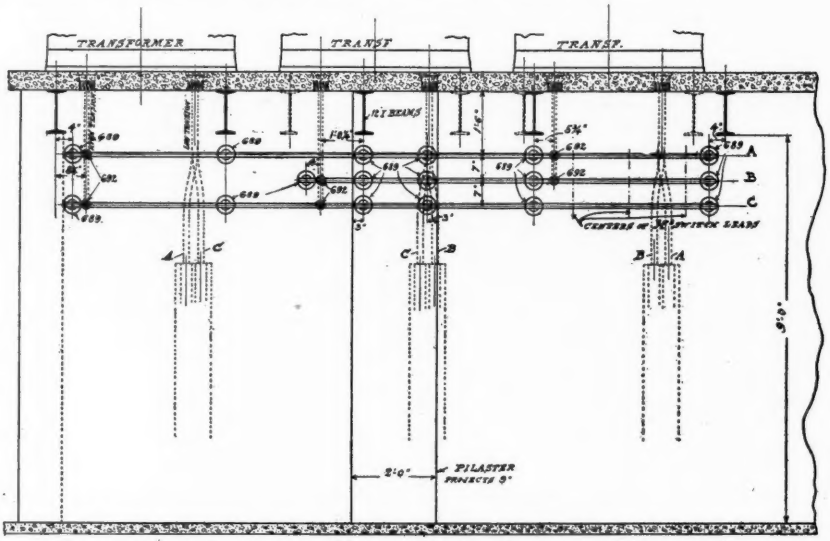


FIG. 5.—DELTA CONNECTIONS, MENTANA STREET SUBSTATION, MONTREAL LIGHT, HEAT AND POWER COMPANY.

ratio of screen area is 460 to twenty-two, or over twenty to one. The drop in air pressure under these conditions is negligible. The use of these air screens is amply justified by the surprisingly large quantity of dirt removed from the pressure side of the screen. This dirt would and will be an automatic check on the thermometer temperature readings.

The air is conveyed from the blower sets to the air chamber through steel plate one-quarter-inch thick housings, stayed at intervals and of easy curves to convey the air into the air chamber with-

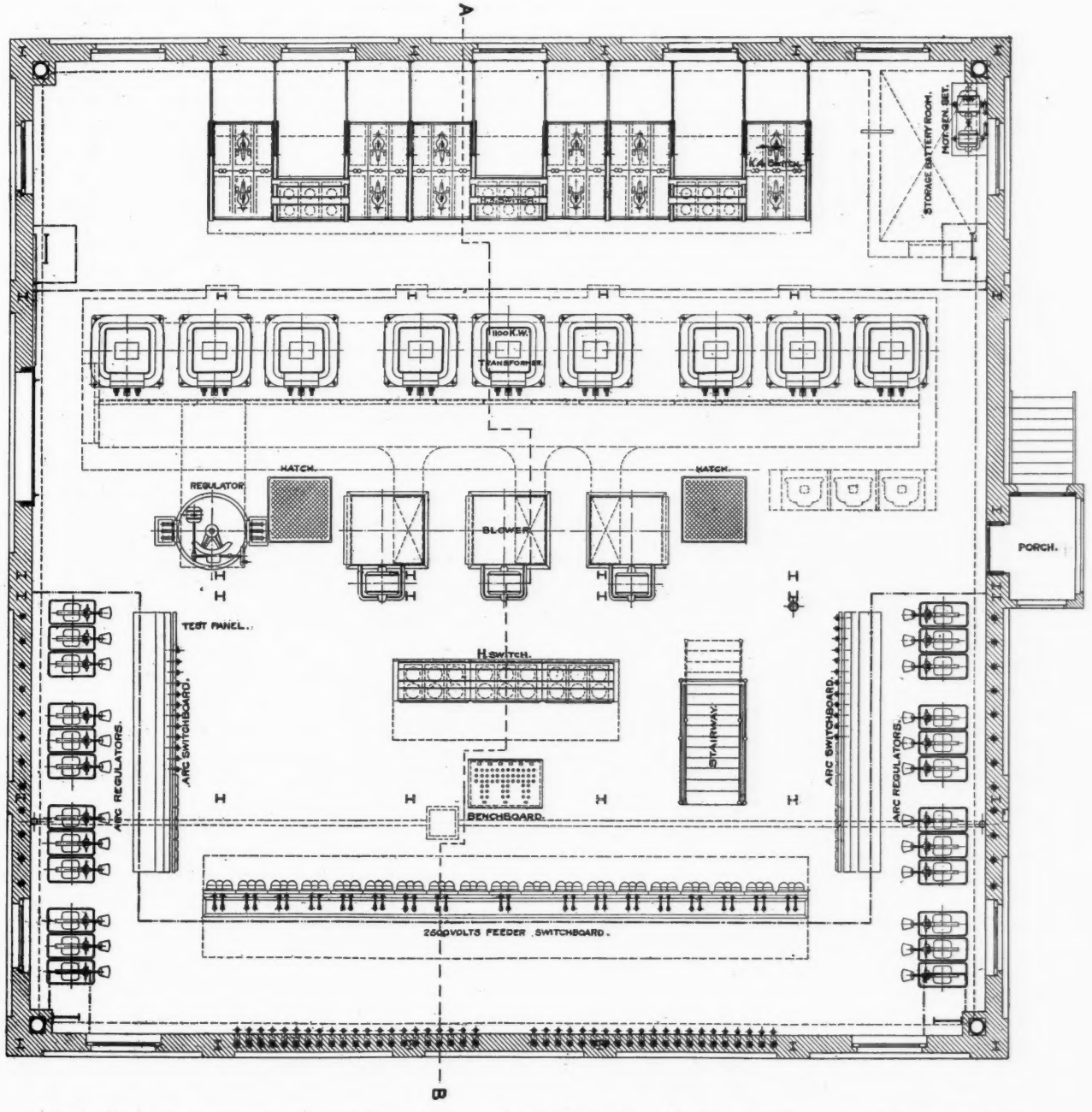


FIG. 6.—DIAGRAM OF GENERAL ARRANGEMENTS, MENTANA STREET SUBSTATION, MONTREAL LIGHT, HEAT AND POWER COMPANY.

otherwise be lodged in the numerous interstices of winding and laminations.

A no-air alarm is being devised so that in case a transformer damper is closed through error, a bell rings and notifies the station attendant that such is the case. This should prevent a slow burnout of a transformer due to lack of air, out shock or without eddy currents or pockets of dead air. The walls of the air chamber are rounded at point of air inlet, as shown on the floor plan to accomplish the same result. The air chamber is entered through two air-tight metal doors, one being on each side of the air screen and each providing a two-foot three-inch by five-foot nine-inch opening. A rubber gasket, which is merely a three-eighths-inch draught tubing or weather-strip held on by a three-eighths-inch by one-quarter-inch wrought-iron bar screwed on, is provided; also a brass wing nut tightening up the door, which already has the three-quarters-ounce per square inch air chamber pressure to close it. These doors, when accurately made and hung, have been found quite satisfactory for the requirements.

The induction regulator has a capacity of 350 kilowatts, with 200 volts range up or down, and cooled by air drawn from

the air chamber and conveyed to where the regulator is located, thence filtering up through the interior of regulator. The two twelve-inch floor beams supporting the regulator are so spaced as to serve as sides of an air duct. A plate was put on top and bottom, thus making an air passage from the air chamber proper to the induction regulator. This regulator is automatic and is also compensated for unequal loads on individual legs of circuits. The capacity, 350 kilowatts, is the nominal rating, but, in reality, the regulator can handle twelve times this amount of power or 4,200 kilowatts of energy continuously. It may be cut out at will by knife disconnecting switches located in the basement. This is shown on the general diagram of connections. No duplicate regulator is provided.

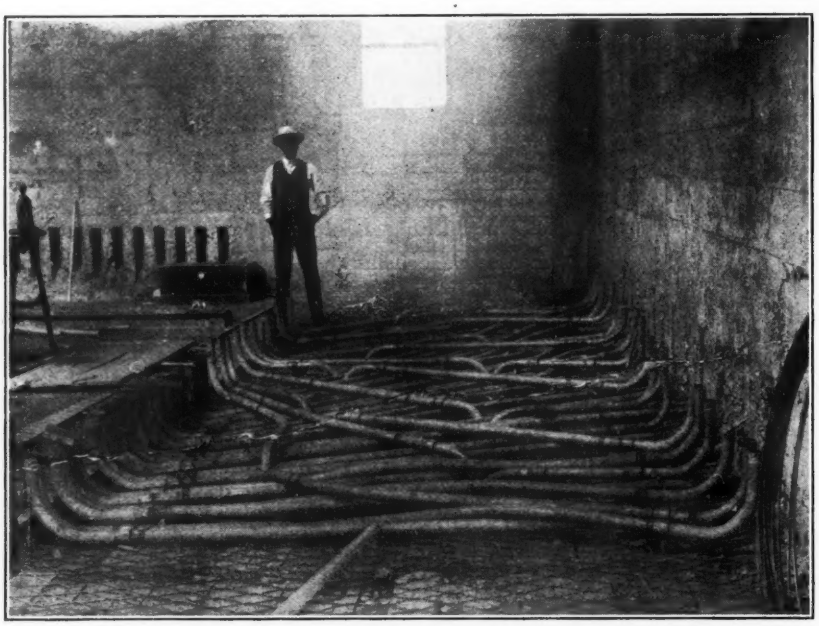


FIG. 7.—NETWORK OF WROUGHT-IRON, CEMENT-LINED CONDUIT FOR CONTROL WIRES, MENTANA STREET STATION, MONTREAL LIGHT, HEAT AND POWER COMPANY.

A plan drawing of the general arrangements of the station is shown in Fig. 6. On leaving the 1,100-kilowatt lowering transformers, the leads are brought, single-phase, to an H-3 oil switch of 1,200-amperes capacity, the delta connection being made just where leads run through the series-current transformers. This arrangement eliminates as much as possible any joints, terminal boards, etc., in the air chamber.

A double 2,400-volt receiving bus is then provided and connected, so that one section, or as many distributing feeders, may be controlled as may be desired. The remaining feeders may be controlled through the induction regulator as may be desired. The remaining feeders or none at all, if desired, may be operated independently of the regulator. This is accomplished through the use of a double 2,400-volt bus-bar arrangement situated immediately under the distributing switchboard panels.

The distributing switchboard consists of fourteen 1,000 kilowatt panels two feet wide, of blue Vermont marble, and three special panels, two being called totality and one auxiliary. The total station output is registered through the totality panels, which have three ammeters, one indicating and one polyphase recording wattmeter, as well as a voltmeter. The auxiliary panel is intended to control a static 500-kilowatt one to one ratio transformer not yet located, or shown on the floor plan. It has also an indicating wattmeter. An auxiliary three-phase bus is also provided and intended to work in connection with the above.

In case an overhead 2,400-volt feeder becomes grounded or defective, the one to one transformer is energized through an oil switch and the defective feeder put on it through the medium of double-blade, single-throw, horizontal disconnecting switches in the basement. Double-bladed switches are used so that the circuit need not be opened, but the transformer cut in before the feeder is taken off the main bus-bars. A wattmeter reading may also be made of any feeder at will by this combination. The auxiliary panel, as already stated, has an indicating and recording wattmeter mounted upon it.

A panel is provided to control the two ten-panel alternating-current series arc switchboard equipments. Iron pipes are laid in the basement floor to carry the 2,400-volt cables, one to each ten-panel equipment.

The house services, all at 110 volts and comprising three seven and one-half-horse-power, alternating-current blower motors, a two-kilowatt motor-generator set for storage battery charging, induction regulator control motor of one horse-power and the house lighting, are all controlled by a special panel and oil switches.

Each panel on this switchboard contains two hand-operating levers for the oil switches in the basement. These are interlocking, and signal lamps are also provided to show which switch is closed and which is open. These oil switches, which are quite heavy, are supported at the back by a heavy bracket bolted onto two one and one-quarter-inch wrought-iron pipes, running from end to end through the cell work barriers. This is a decided improvement on the usual method of setting bolts or studs through the centre wall, which, as a rule, is well occupied with ducts. The pipes may also be lined up more readily than bolts, as formerly used. These switches are automatically tripped by the usual bellows type time-limit relay, set to predetermined time limits. The current transformers tripping these relays and controlling the various panel measuring instruments are shown (Fig. 4) just above the division cell wall in the basement.

A benchboard is provided with hand-control switches. From this point all the K switches controlling incoming or outgoing tie-lines are opened. This benchboard also opens the H-3 oil switches controlling primary and secondary of lowering banks of transformers. Three twenty-kilowatt, 2,400-volt, 110-volt transformers are installed in the basement and carefully isolated by concrete barriers and covers. These furnish the 110-volt current for above services. A panel with open knife switches and fuses is provided to start up or control any or all of the station services just mentioned.

The motor-generator set of two-kilowatt capacity is used for charging a fifty-five-cell storage battery having a discharge ratio of twenty amperes per three hours.

A special panel is installed with underload and overload circuit-breakers; also ammeter and voltmeter. This panel also controls throw-knife switches, the benchboard, oil switch, direct-current bus for opening and closing oil switches. Attention is drawn to the method of bringing in the 11,000-volt tie-line conductors.

These are of 2/0 B. & S. gauge and are eighteen in number. The lines are terminated on a strain insulator of standard make. From there a wire is run through a standard bushing made for this voltage, thence through the station wall and in the building, all the wire being bare.

The roof proper is carried out thirty inches horizontally, and a front, two ends and bottom are bolted on. These consist of about one and one-half-inch thick concrete slabs, fairly weatherproof at the joints. This roof extension has some ornamental features and the whole has a pleasing external effect from the street.

The lightning protection on the 2,400-volt feeders and arc circuits consist of the usual single-pole lightning arresters and choke coils, all carefully subdivided by soapstone barriers. Double-pole arrester units have been found unreliable for this work. The barriers are at least eighteen inches deep. Anything less than this has been found unsuitable to confine any arcing.

How the Telegraph Operator Surprised the Actor.

O. L. Perry, the Fort Wayne manager of the Western Union for over thirty years, tells a story of Oliver Doud Byron, the veteran actor, who recently gave a dinner to a party of friends in New York, which reminded Perry of the incident.

"Byron," said Perry, "was playing in Fort Wayne in a piece that called for a telegram informing the operator away ahead of the express train to stop the train, loaded with gold, as bandits were waiting to hold it up. In a dramatic situation Byron as the hero operator at one point clicks the instrument, and there is a strenuous pause to know if the message arrived in time. I was selected to send the message that would tell Byron his warning had been given and the engineer had been notified.

"He knew nothing about telegraphy and what he clicked off had no meaning, of course. At the proper cue I clicked off the words: 'Byron, you may be a good actor, but you are a blame poor operator.'

"There was a tremendous outburst of applause over spots in the audience. It happened that there were a good many railroad men who knew the code in the audience, and when they heard the message they saw the point. It was a good while before Byron could proceed with the play without interruption, and he does not know yet what caused the commotion."—*Indianapolis News.*

Report on the Government Fuel Investigations.

For the purpose of investigating the fuels of the United States, Congress appropriated during the year 1904, in three acts, sums aggregating $85,000. A preliminary report covering the results of the investigations made under this authorization has already been printed as bulletin No. 261 of the Geological Survey series, and a more complete and instructive final report of the work done during that period is now going through the press as professional paper No. 48.

During the current fiscal year these investigations are being conducted at St. Louis, on the same site that was used during 1904. The equipment has been enlarged by the purchase of necessary instruments and machinery and by the construction of storage bins, conveyers and other facilities for the handling of coal. Occupation, without rental charge, of two additional buildings formerly used by the Louisiana Purchase Exposition, has afforded the experts laboratory facilities. Office facilities have also been made adequate by obtaining the use, at a nominal rent, of another of the former exposition state buildings. The object of the investigations is indicated in the wording of the act referred to above, namely, "the analyzing and testing of the coals, lignites and other fuel substances, in order to determine their fuel values, and so forth."

The samples of coals and lignites for these investigations have been and are being collected with great care by men trained for this purpose. The work is being extended to all the important coal fields of the United States. The coals and lignites brought to the testing plant are analyzed and tested as to their suitableness for use under the steam boiler, in the gas producer and in coke ovens; as to how far their quality may be improved by washing and as to the ease with which they may be briqueted for fuel purposes.

A report issued under date of February 3, 1906, by Charles D. Walcott, director of the Geological Survey of the United States, points out the very great need of continuing this work, and details the great amount of work which has already been undertaken and the very satisfactory results achieved.

The fuel-testing plant is still located in Forest Park, St. Louis, on the exposition grounds. Owing to the public improvements under way there and the lack of transportation facilities after July 1 next, it will be necessary to remove the plant to another site by that date. This removal, reinstallation and necessary new equipment will require an expenditure of $50,000. Director Walcott therefore recommends the following appropriations for the fiscal year ending June 30, 1907: "for the investigation of the coals, lignites and other fuel substances of the United States, in order to determine their fuel values, and so forth, under the supervision of the director of the United States Geological Survey, and at such places as he may deem most advantageous, $200,000; for the removal of the plant and necessary equipment, $50,000."

The Geological Survey has entered upon a technical investigation of fuels and structural materials in response to the general public demand for information rather than from any theoretical consideration. It is this increasing demand for information coming from the engineers, architects and builders in all parts of the country, caused by the rapid changes which are taking place in the materials used for construction work, that causes Director Walcott to recommend both that this investigation of structural materials be continued and that the appropriation be largely increased. Director Walcott recommends the following appropriation for the fiscal year ending June 30, 1907: "for the investigation of materials used in building and construction work, under the supervision of the director of the United States Geological Survey, $100,000."

In order that the investigation of fuels and structural materials might be brought into closer touch with both the users and producers of fuels and structural materials, the officers of the national engineering and allied societies were asked to suggest the names of one or more of their members who might be appointed members of a national advisory board on fuels and structural materials. The following list of persons selected from the membership of these societies has been presented to President Roosevelt, he has formally approved the plan, and has appointed these persons as members of the National Advisory Board for Fuels and Structural Materials:

LIST OF MEMBERS OF THE NATIONAL ADVISORY BOARD OF FUELS AND STRUCTURAL MATERIALS.

American Institute of Mining Engineers: John Hays Hammond, past-president, Empire Building, New York; Robert W. Hunt (of Robert W. Hunt & Company, testing engineers, Chicago, Pittsburg and New York), Chicago, Ill.; B. F. Bush, manager and vice-president, Western Coal and Mining Company, St. Louis, Mo.

American Institute of Electrical Engineers: Francis B. Crocker, professor of

electrical engineering, Columbia University, New York; Henry G. Stott, superintendent of motive power, Interborough Rapid Transit Company, New York.

American Society of Civil Engineers: C. C. Schneider, president; chairman Committee on Concrete and Reenforced Concrete, Pennsylvania Building, Philadelphia, Pa.; George S. Webster, chairman, Committee on Cement Specifications; city engineer, City Hall, Philadelphia, Pa.

American Society of Mechanical Engineers: W. F. M. Goss, dean of the School of Engineering, Purdue University, Lafayette, Ind.; George H. Barrus, steam engineer, Pemberton square, Boston, Mass.; P. W. Gates, 210 State street, Chicago, Ill.

American Society for Testing Materials: Charles B. Dudley, president, Altoona, Pa.; Robert W. Lesley, vice-president, Pennsylvania Building, Philadelphia, Pa.

American Institute of Architects: George B. Post, past-president, 33 East Seventeenth street, New York; William S. Eames, past-president, Lincoln Trust Building, St. Louis, Mo.

American Railway Engineering and Maintenance of Way Association: H. G. Kelley, president, Minneapolis, Minn.; Julius Kruttschnitt, director of maintenance and operation, Union Pacific Railroad, 135 Adams street, Chicago, Ill.; Hunter McDonald, past-president; chief engineer, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

American Railway Master Mechanics' Association: J. F. Deems, general superintendent of motive power, New York Central Lines, New York; A. W. Gibbs, general superintendent of motive power, Pennsylvania Railroad, Altoona, Pa.

American Foundrymen's Association: Richard Moldenke, secretary, Watchung, N. J.

Association of American Portland Cement Manufacturers: John B. Lober, president, Land Title Building, Philadelphia, Pa.

Geological Society of America: Samuel Calvin, professor of geology, University of Iowa, Iowa City, Iowa; I. C. White, state geologist, Morgantown, W. Va.

Iron and Steel Institute: Julian Kennedy, metallurgical engineer, Pittsburg, Pa.; C. S. Robinson, general manager, Colorado Fuel and Iron Company, Denver, Col.

National Association of Cement Users: Richard L. Humphrey, president, St. Louis, Mo.

National Board of Fire Underwriters: Chas. A. Hexamer, chairman, Board of Consulting Experts, Bullitt Building, Philadelphia, Pa.

National Brick Manufacturers' Association: John W. Sibley, treasurer, Sibley-Menge Press Brick Company, Birmingham, Ala.; Wm. D. Gates, American Terra Cotta and Ceramic Company, Chicago, Ill.

National Fire Protective Association: O. U. Crosby, chairman, Executive Committee, 76 William street, New York.

National Lumber Manufacturers' Association: Nelson W. McLeod, president, Equitable Building, St. Louis, Mo.; John L. Kaul, president, Southern Lumber Manufacturers' Association, Birmingham, Ala.

Corps of Engineers, United States Army: Lieutenant-Colonel Wm. L. Marshall, Army Building, New York.

Isthmian Canal Commission: Lieutenant-Colonel O. H. Ernst, Washington, D. C.

Bureau of Yards and Docks, United States Navy: Civil Engineer Frank T. Chambers, Washington, D. C.

Supervising Architect's office, United States Treasury Department: James K. Taylor, supervising architect, Washington, D. C.

Reclamation Service, United States Interior Department: F. H. Newell, chief engineer, Washington, D. C.

American Electrochemical Society.

A preliminary announcement of the next general meeting of the American Electrochemical Society has been issued. This meeting will be held at Ithaca, N. Y., May 1, 2 and 3. It is planned to have the headquarters at the Ithaca Hotel.

The forenoons will be devoted, as usual, to the reading and discussion of papers. On Tuesday afternoon an inspection of the chemical laboratory, dynamo and engineering laboratories and shops of Cornell University will be made. On Tuesday evening the address of the retiring president, Dr. Wilder D. Bancroft, will be delivered and a smoker will be held at the Town and Gown Club. On Wednesday afternoon visits will be made to the filtration plant, to the hydraulic laboratory, to the university power plant situated in the gorge and to the Ithaca Gun Company's plant. On Wednesday evening the usual subscription dinner will be held. On Thursday afternoon visits will be made to the Remington Salt Company's works and possibly to the plant of the Morse Chain Works.

Ithaca can be reached either over the Lehigh Valley Railroad or by means of the Lackawanna.

The following is a list of the authors and papers promised for this meeting:

C. F. Carrier, Jr., "The Extraction of Sodium."

J. W. Richards.

Maximilian Toch, "Electrolysis."

John Nelson, "The Effect of Oxides on the Adhesiveness of Electrodeposited Metals."

W. H. Walker, "An Instructive Laboratory Experiment in Applied Electrochemistry."

F. F. Colcord, "Impurities in Electrolytic Copper."

A. Van Winkle, "Electro-Galvanizing."

G. A. Hulett, "Standard Cells."

W. D. Bancroft, "Lecture-Room Switchboard."

G. R. White, "Alternating-Current Electrolysis with Cadmium Electrodes."

G. R. White, "Ferromanganese Anodes in Caustic Potash."

B. E. Curry, "Electrolytic Corrosion of Copper-Tin Alloys."

H. M. Goodwin and R. D. Mailey, "On the Physical Properties of Fused Magnesium Oxide."

M. DeK. Thompson, Jr.

L. Kahlenberg and A. S. McDaniel, "Differences of Potential between Manganese and Lead Peroxides and Various Aqueous and Non-Aqueous Solutions."

C. F. Burgess and S. G. Engle, "Observations on the Corrosion of Iron by Acids."

F. K. Cameron, "The Movement of Suspended Clay and Other Similar Particles Under the Influence of the Current."

H. M. Goodwin and H. A. Wentworth, "Electrometric Experiments with Reference to the Dissociation of Fused Salts."

G. A. Hulett, "Cadmium Standard Cell."

Isaac Adams, "The Development of the Nickel-Plating Industry."

G. I. Kemmerer, "Cathodic Disintegration of Carbon in Electrolyte of Fused Chloride."

W. C. Arsem, "The Electric Vacuum Furnace."

O. W. Brown, "The Reduction of Metal Sulphides."

O. P. Watts, "A New Silicide of Molybdenum."

C. F. Burgess and O. P. Watts, "A Microscopic Study of Electrodeposits."

L. Lyndon, "Electrolyte Density in Storage Cells."

C. L. Collins, 2d, "Title to be announced."

E. S. Shepherd, "Errors in Pyrometry."

G. R. White, "Laboratory Resistance Furnaces."

B. E. Curry, "Electrodeposition of Bronze."

R. C. Snowdon, "Electrolysis of Lead Acetate Solutions."

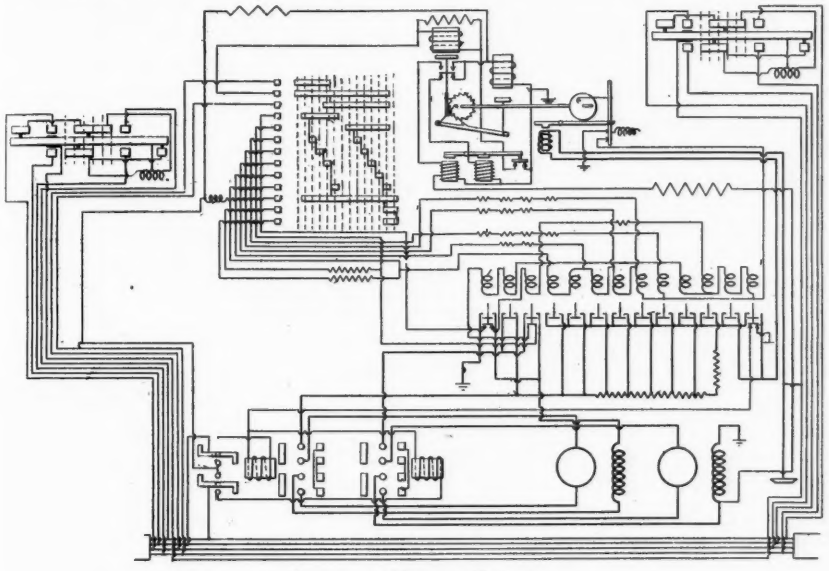
The secretary of the society is S. S. Sadtler, 39 South Tenth street, Philadelphia, Pa.

National Electric Light Association.

The Trunk Line Association and the New England Passenger Association have authorized a rate of a fare and one-third, on the certificate plan, from points in their respective territories to Atlantic City, N. J., and return, for delegates and their friends attending the twenty-ninth convention of the National Electric Light Association, June 5 to 8. Negotiations are under way with other associations to obtain the same rate.

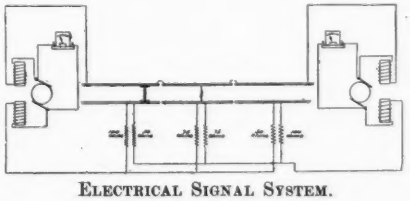
Electrical Patents.

Thomas S. Perkins and Ray P. Jackson, of Wilkinsburg, Pa., have obtained a patent (814,323, March 6) for an improved system of remote control for electric motors, assigning it to the Westinghouse Electric and Manufacturing Company. The invention relates to systems of control for electric motors and particularly to such systems as are employed to control from a remote point or any one of several remote points one or more individually operated units, each of which is equipped with two or more electric motors. The object of the invention is to combine into a system of extreme simplicity all of the controlling and protective means necessarily and ordinarily employed in connection with electric motors. An important and novel feature of the invention consists of a plurality of electromagnetically operated controller drums, one for each individually operated unit, and all of which shall be so governed from a remote simple master-switch that they may be rotated automatically step by step at a predetermined rate and may be stopped and started again or returned to their initial positions at the will of the operator. These controllers govern the circuits of electromagnetically operated switches located in the motor circuits, the number and combinations of which may be readily varied without the use of complicated relays or extra control-wires. A novel limit device operates at any notch to prevent further rotation of the controller drum if and while the current taken by the motors exceeds a certain predetermined amount, and an overload on the motors effects the operation of a release which allows the switches in the motor circuits to open and make necessary the return of the operating switch to the "off" position before current can be again supplied to the motors. One of the chief advantages of the invention lies in the fact that ordinarily only four train-wires are required in order to control the operation of all the motors—viz., one wire for each of the forward and reverse positions of the reverse-switch and one for each of the full series and full parallel positions of the master-switch. If more running positions are desired, a control-wire must be employed for each additional position.



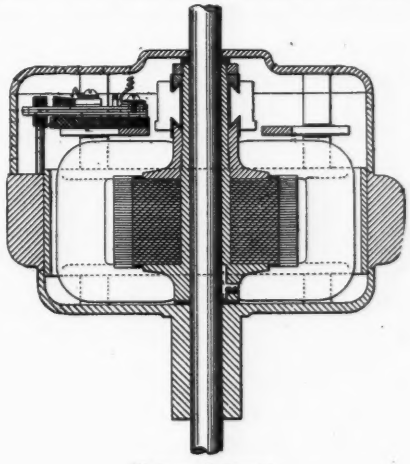
System of Remote Control.

An improved electrical signal system has been invented by Fred Lacroix, San Antonio, Tex., and he has assigned one-half to Otto Koehler, of the same place (814,302, March 6). The invention relates to improvements in electrical systems whereby the position of a train anywhere between the ends of a track can be ascertained at either terminal. In carrying out the invention a normally open electrical circuit is provided which will be closed by a conductor, such as the wheels and axle of a locomotive electrically connecting the two rails of the track. The circuit is divided into sections of different resistances and at the terminal of the circuit are indicators, such as voltmeters, for determining the resistance offered by the circuit to the passage of the current. Each section of the circuit has a fixed resistance different from the resistances of any other section. When the circuit is completed through a particular section by the wheels and axle of a car or engine, by observing the indicator which registers the resistance of that particular section, the location of the train can be determined from either end of the track.



Electrical Signal System.

Charles A. Eck, Newark, N. J., has obtained a patent (813,410, February 27) for an improved motor control. The invention relates generally to motor control, and has more particularly reference to means for varying the resistance of the magnetic circuit of the motor. The object of the invention is to provide a simple and efficient means whereby a motor can be controlled—that is, whereby the speed and power can be regulated. To this end the invention comprises, essentially, an adjustable yoke between the poles whose sectional area varies so that when the yoke is adjusted to one position the magnetic lines of force will flow through that portion of the yoke having a large cross-sectional area, and when adjusted to another position the magnetic lines of force will flow through that portion of the yoke whose cross-sectional area is smaller. The invention consists in the combination with a motor, having a casing, poles and an armature, of a contacting plate stationary with the motor, a switch lever adapted to be moved into contact with the plate, a yoke-ring circumferentially adjustable on the casing and having alternating portions of large and small cross-sectional area, means on the yoke-ring for moving the switch lever into contact with the plate when turned in one direction, and out of contact with the contact plate when turned in the opposite direction, and a spring for pulling the switch lever away from the contact plate on a quick action.



Motor Control.

Reviews of Current Engineering and Scientific Literature.

Peculiarities of the Rays of Radium.

An interesting communication by Mr. E. Rutherford discusses certain peculiarities of the α rays of radium. He reviews briefly the previous experimental researches on this subject, particularly the work of Becquerel, and gives results of his own experiments. He exhibits a number of photographic records illustrating the points brought out in the discussion. The results of this study are summed up as follows: the α rays of radium having equivalent activity are of a complex nature, and consist of particles thrown off with different velocities. The velocity of the α particle decreases during its passage through air and through aluminum. The absence of marked deflecting of the rays from a thick layer of radium after this is passed through aluminum foil is noteworthy evidence in favor of this view. The larger radius of the deflection path followed by these rays through air is also evidence of the complex character. There is apparently a marked dispersion of the rays of radium C when these pass through air.—*Translated and abstracted from Physikalische Zeitschrift* (*Leipsic*), *March* 1.

Electric Lighting at Tientsin.

A description is given here of the electric lighting system of the British settlement at Tientsin, China. The plant was put into service the latter part of August of last year. Up to this time light for the settlement had been supplied by an oil-gas system. The same company has built the new electrical plant. It offers the town the option between gas and electricity, and it is said that electric lighting is carrying the day. The power plant is located in a building about sixty feet by sixty-seven feet. There are three generating sets, two rated at eighty kilowatts and one at forty kilowatts. These are driven by high-speed steam engines. The distribution is by means of the three-wire system, with static balancers capable of dealing with the twenty-five per cent out-of-balance current. The boiler plant consists of two Babcock & Wilcox standard boilers. There are also an economizer and two Worthington condensers. The streets are lighted by 234 thirty-two-candle-power incandescent lamps attached to ornamental brackets fitted on the poles. The overhead system has been erected substantially, iron lattice poles or Mannesmann tubes being used. An equivalent of 6,500 eight-candle-power lamps has been connected. The maximum load up to the present time is eighty-eight kilowatts. Energy is sold at about sixteen cents per kilowatt-hour. The coal obtained is fairly cheap and good. The operating staff consists of two European engineers and a number of Chinese subordinates, who attend to the lamps, fire the boilers and do the clerical work.—*Abstracted from the Electrical Review* (*London*), *February* 23.

Atomic Disintegration.

Evidence in support of Rutherford's theory of atomic disintegration of radioactive elements is piling up, and many competent investigators do not hesitate to apply the same theory to other elements. In this communication Herr W. Meigen considers a possible phase of this theory. The enormous amount of energy set free in the formation of helium renders hopeless any attempts to reverse the process. Considering the conformity of the other gases of the helium type—neon, argon, krypton and xenon—it seems probable that they owe their existence to a similar disintegration of atoms. It is not surprising, therefore, that all attempts have failed to obtain a chemical compound of these gases, and the author does not think such attempts likely to succeed in the future. That as yet these gases, excepting helium itself, have not been recognized as products of atomic disintegration may be due to their difficult test. With these facts in mind, it seems to Herr Meigen that there is nothing contrary to the view that disintegration of atoms is an irreversible process strictly analogous to distribution of heat. Considered in this way there exists a parallelism not only as regards the first law of thermodynamics (the conservation of energy) with the principle of the conservation of matter, but also with regard to the second law, distribution of energy on the one hand, and atomic disintegration on the other. As it has been stated by Clausius that the world's entropy tends toward a maximum, we may say that likewise the quantity of free helium and the similar "Edelgase" tends toward a maximum. This parallelism in material and energetical law appears to the author worthy of notice.—*Abstracted from Nature* (*London*), *February* 22.

The Electric Railway of Seoul, Korea.

In an interesting article on the railroads and foreign enterprises of Korea, by Mr. L. E. Bennett, who recently inspected these industries in that country, the author describes briefly the electric railway of Seoul and the difficulties under which it was constructed and is now operated. The concession for the construction of this road was granted some years ago. It was to be exclusive and to run for twenty-five years. From the type of construction adopted it seems that the road was built to sell and not to operate. It was opened in 1899, but almost immediately stopped by the natives, who forcibly tore up part of the track, burned the cars and caused considerable loss to the company. There was an unusually long drought in the country and the natives said that the power-house rested on the rain dragon's back, and that crops were being destroyed because he could not do his work. Two days after the riot the rain came, but the operation of the road was not resumed until six months later, when American motormen and conductors were employed in place of the former Japanese. These men commanded salaries of $100 per month, which added considerably to the expense of operating, and, in fact, caused a loss. In 1903 these men were replaced by Koreans at $10 a month, and since then the earnings have steadily increased. The advantages of the road are now recognized by the people and all prejudice has been overcome. However, the road is not patronized much because of the limited means of the people and because of the poor service offered. The road is operated by the American-Korean Electric Company, which company also started the electric light service in Seoul in 1901. The demand for electric light continues and is now in excess of the supply. The trolley lines served by the plant have a mileage of about eleven. It is attempted to give a five-minute service on the principal part of the line. Due to the overload of the station it is purposed to rebuild the power plant and increase its output greatly. It is also intended to rebuild the railway at the same time and to add about five miles to the suburban section. The road is operated on the zone system, the fares charged for each zone being about two and one-half cents, corresponding to about one cent per mile. Mr. Bennett believes that the sensible

thing to do is to consolidate this system with the Chemulpo & Seoul Railway, which is twenty-six miles long, and to operate both lines electrically. At the same time the Chemulpo electric light plant could be operated by the company.—*Abstracted from the Railroad Gazette (New York), March 9.*

Phase Meters and Their Calibration.

An interesting study of phase meters and a convenient method of calibrating them is given here by Dr. W. E. Sumpner. Phase meters are instruments closely allied to voltmeters and wattmeters. The chief difference arises in the number of circuits used in the instruments. Dynamometers only have coils for two circuits, the one fixed and the other movable. Phase meters have at least three such circuits, and may have as many as six. The theory of the instrument is explained by assuming a design in which there are three fixed and one movable coil. If currents be allowed to flow through all of these coils, the movable coil will be acted upon by a deflecting force due to each coil. It will therefore tend to set itself in such a position as to reduce the resulting turning force to zero. These deflecting forces are factors of the effective values of the currents flowing and the constants of the instrument, and they are therefore the same for equivalent values of current, whether it be alternating or direct. For this reason it is convenient to calibrate the instrument by means of direct currents, care, of course, being taken to maintain the proper relationship between the currents in the different circuits. This is not difficult to do if the fixed coils be connected up so that one of them may be considered as the return circuit for the other two. The movable coil, of course, corresponds to the voltage of the system. It should be noted that this simple treatment of the subject applies only to balanced loads. When the load becomes unbalanced, an error is introduced in the readings of the instrument and the theory becomes exceedingly complex. With the coils grouped as above, it then becomes necessary to regulate the current in two of the fixed coils only, so as to maintain the proper proportions. The instrument will then be deflected to a position corresponding to a power-factor, which would give the same current and voltage relations. Dr. Sumpner has constructed phase meters according to this theory and tested them with good results. In one instrument of this type iron laminations were employed for the magnetic circuit, the coils being wound in twelve slots on the interior. The movable coil was placed within. This toothed arrangement produced a certain error, due to the uneven distribution of flux in the air-gap, although this was partially corrected by skewing the laminations. The calibration curve of this instrument showed a series of steps due to the teeth, but with an even distribution of the coils these steps disappeared. Tests of the instrument, both by alternating and direct current, gave results entirely concordant throughout the range of the meter.—*Abstracted from the Electrician (London), February 23.*

Magnetic Field and Coronal Streamers.

In the course of an investigation of the phenomena presented by electric discharges in strong magnetic fields, Dr. John Trowbridge soon found that phenomena appear at high voltages together with strong, steady currents which do not manifest themselves at lower voltages and lesser currents. He has therefore extended his experiments, using voltages ranging from 3,000 to 8,000, with currents of from five milliamperes to twenty milliamperes and with fairly large tubes. With pressures varying from one centimetre to one millimetre within the tube, the cathode light on a circular aluminum plate three centimetres in diameter, forming the pole of a powerful magnet, the magnetic lines of which are directed along the line of electric discharge, is driven to the circumference of the disc, forming to the eye an apparently steady circular discharge. When the tube, however, is covered with black paper, exposing only the light of the disc, and this light is examined in a revolving mirror, it is seen that this is an interesting case of unipolar rotation. The speed of revolution also increases with the degree of exhaustion of the rarefied air. When the free path of the ions increases, the progressive effect along the magnetic lines becomes more than the rotation effect of the magnetic field. When the plate forming the anode is also the end of a magnetic pole, the lines of magnetic force being directed along the line of electric discharge, the light of the anode is separated into two distinctly different lights, one, in rarefied air, a plume-like rosy light, the other a plume-like violet light. These discharges also revolve around the pole near the centre of the disc instead of on the circumference, as in the case of the cathode discharge. These latter discharges are difficult to follow in a revolving mirror and they have not been photographed; but it is certain that they revolve. This phenomenon leads Dr. Trowbridge to connect the phenomenon of coronal streamers seen at the poles of the sun during an eclipse with the effect of a magnetic field on possible electric discharges between the equatorial regions of the sun and its poles. Supposing that a difference of electrical potential can arise between the swiftly moving strata of gases or from the eruptions—mostly along the equatorial belt and the polar regions—the supposed magnetic poles of the sun would undoubtedly tend to cause the resulting electric discharges to revolve about the pole. On account of the vast circumferential area about the poles, a number of discharges could occur at different points around the pole, and each discharge would revolve under the effect of the pole. On observing the effect of a strong magnetic pole on the plate terminals in wide tubes of rarefied air at comparatively high pressure of air under conditions of high electromotive force and great current density, one can observe phenomena of rotation which can not be photographed, yet which present to the eye a strong analogy to the appearance of coronal streamers. Another interesting magnetic phenomenon which may have bearing on the coronal streamers at the poles of the sun: when the lines of magnetic force are at right angles or transverse to the direction of the electric discharge, at comparatively high pressures—one and two centimetres—with currents of from five to twenty milliamperes, 3,000 to 8,000 volts, in wide tubes, streamers radiate from the position of the magnetic pole. Another action of the magnetic field on vacuum discharge is to facilitate the production of X-rays. Experiments were conducted by Dr. Trowbridge with specially constructed X-ray bulbs, which enabled him to obtain a fairly strong magnetic field, directed along the path of the ray. It was found that this field acted to produce X-rays at a lower voltage than that necessary when the field was absent. In addition to the scientific interest of this phenomenon, there is a possible practical use of it for regulating the action of X-ray bulbs. At the present time, when the vacuum is raised to a point where it is necessary to heat the bulb in order to secure the rays—an action rather dangerous to the life of the tube—a magnetic regulator can be introduced which produces the same result more easily and by a method which is under perfect control, and which, moreover, does not endanger the life of the tube. The magnetic regulator is not only safe, but is constant in its action, and enables the operator to pass readily from hard to soft rays. It is difficult to do this by the methods which are at present employed.—*Abstracted from the American Journal of Science (New Haven), March.*

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

In recent issues of the ELECTRICAL REVIEW we have reproduced several examples of attractive literature which has been made use of by the publicity departments of central stations. There is no way in which so much instruction can be gained with reference to the relative values of type display and artistic representations than by a study of various samples of good printing and display which have been successfully made use of by progressive central station managers. In this article it is intended to present reproductions of some of the literature recently

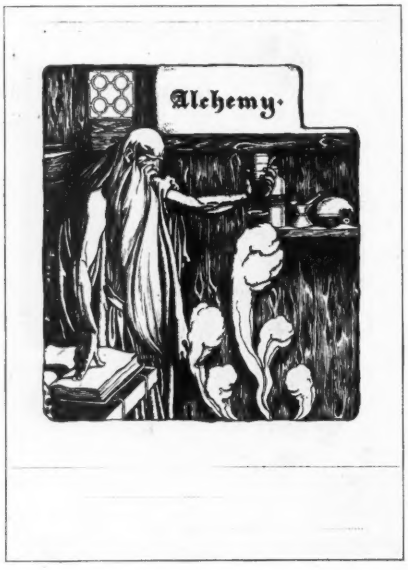


FIG. 1.—FOLDER FROM EDISON ILLUMINATING COMPANY OF BROOKLYN.

produced, calling attention to the characteristic points and suggesting sizes and the color treatment. This is not done with the intention of suggesting any direct method of copying or reproducing samples herewith illustrated. Special conditions require special treatment. The folder or mailing card which is applicable for Philadelphia or Boston would probably fall far short of the requirements of Denver or San Francisco. It is the study of the general effect produced by the harmonious grouping of ideas and letters that naturally leads one to do more concentrated thinking on the matter of attractive publicity, and in this way many ideas of great practical value and usefulness are developed.

Fig. 1 and Fig. 2 illustrate a folder recently issued by the Edison Electric Illuminating Company of Brooklyn, Brooklyn, N. Y. This folder, when closed up, measures five and one-half by seven and one-half inches, and when opened measures five and one-half by fourteen inches.

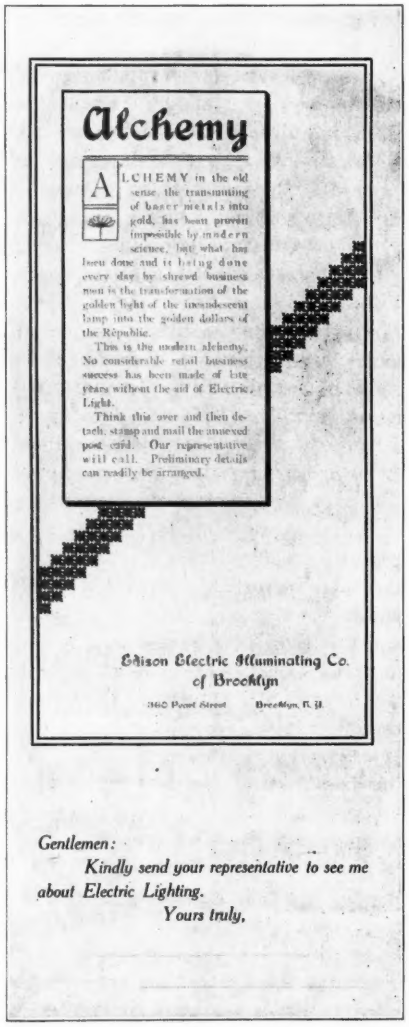

Alchemy
ALCHEMY in the old sense, the transmuting of baser metals into gold, has been proven impossible by modern science, but what has been done and is being done every day by shrewd business men is the transformation of the golden light of the incandescent lamp into the golden dollars of the Republic.
This is the modern alchemy. No considerable retail business success has been made of late years without the aid of Electric Light.
Think this over and then detach, stamp and mail the annexed post card. Our representative will call. Preliminary details can readily be arranged.
Edison Electric Illuminating Co. of Brooklyn
360 Pearl Street Brooklyn, N. Y.
Gentlemen:
Kindly send your representative to see me about Electric Lighting.
Yours truly,

FIG. 2.—FOLDER OPENED UP.

The color scheme is a bright green for the cover, with the inside leaf printed in blue and green. This carries a return postal, which is easily separated from the body of the folder by means of perforations. While this circular is a very attractive piece of typography, the suggestion is not as clean-cut as several others which we have noticed from the same company. The meaning is more or less hidden, and it is a question whether it pays

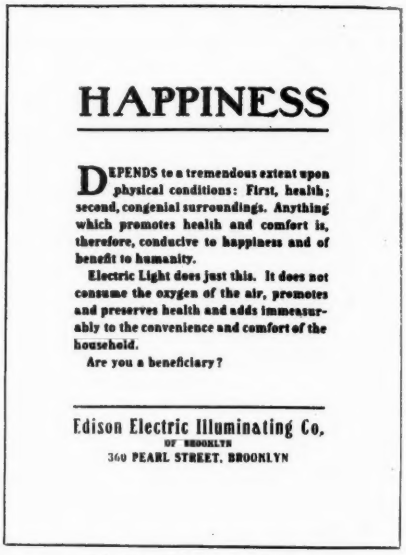

HAPPINESS
DEPENDS to a tremendous extent upon physical conditions: First, health; second, congenial surroundings. Anything which promotes health and comfort is, therefore, conducive to happiness and of benefit to humanity.
Electric Light does just this. It does not consume the oxygen of the air, promotes and preserves health and adds immeasurably to the convenience and comfort of the household.
Are you a beneficiary?
Edison Electric Illuminating Co.
OF BROOKLYN
360 PEARL STREET, BROOKLYN

FIG. 3.—MAILING CARD.

to have a prospective customer think out the inference rather than to bring him to the subject at a glance. It is this matter of bringing to a customer's mind the idea in which the company and the customer are both, or should be, interested that makes valuable the attractive catch-line.

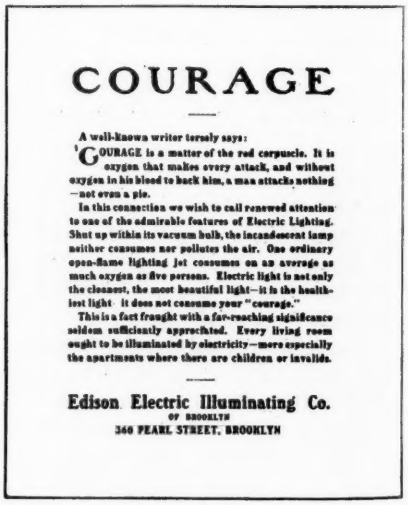

COURAGE
A well-known writer tersely says:
'COURAGE is a matter of the red corpuscle. It is oxygen that makes every attack, and without oxygen in his blood to back him, a man attacks nothing—not even a pie.
In this connection we wish to call renewed attention to one of the admirable features of Electric Lighting. Shut up within its vacuum bulb, the incandescent lamp neither consumes nor pollutes the air. One ordinary open-flame lighting jet consumes on an average as much oxygen as five persons. Electric light is not only the cleanest, the most beautiful light—it is the healthiest light. It does not consume your "courage."
This is a fact fraught with a far-reaching significance seldom sufficiently approached. Every living room ought to be illuminated by electricity—more especially the apartments where there are children or invalids.
Edison Electric Illuminating Co.
OF BROOKLYN
360 PEARL STREET, BROOKLYN

FIG. 4.—MAILING CARD.

The few words which seize the attention immediately convey the idea and hold the interest of the prospect.

Fig. 3 and Fig. 4 demonstrate this idea in better fashion. The suggestions are logical and the matter of employing

FIG. 5.—AN ATTRACTIVE FRONT PAGE.

electric light is shown to be of primal importance, while the typographical treatment is simple in the extreme, at the same time being attractive and distinctly legible. These cards are of heavy white stock, five and one-quarter by seven inches, printed in blue ink.

Fig. 5 and Fig. 6 are reproductions of the front page and inside, respectively, of a folder recently distributed by the same

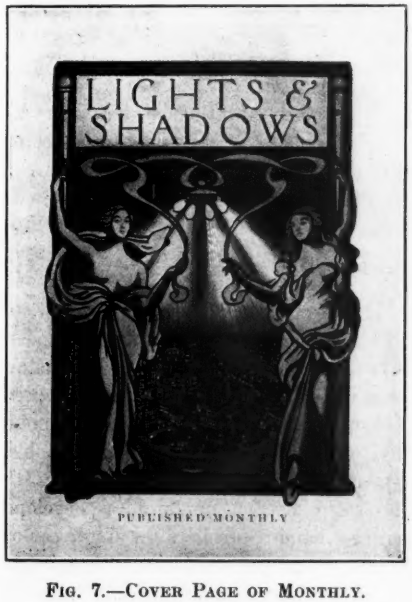


FIG. 7.—COVER PAGE OF MONTHLY.

company. In this instance the title page secures attention, because it conveys to the prospect something that is of importance to him. The significant statement on the inside, "electric signs bring business," secures the attention, and the statement that the Edison company will pay for the sign, worded to suit, and install it free of charge on the premises is a matter that very few business men will pass without consideration.

NASSAU TRUST COMPANY
Electric Signs
Bring Business
DRUGS
Secure a Sign that Shines in the Night and Burn Your Name Into the Public Mind
THE EDISON CO. WILL PAY FOR THE SIGN
YOU PAY FOR THE LIGHT
WINES
And since recent reductions, Electric Light in Brooklyn is now Cheap. You can operate an Electric Sign for as low as five dollars a month, the cost ranging up from this minimum, according to the number of lamps in the sign. It would be impossible for you to spend from five to twenty-five dollars a month (according to the size of your store and the needs of your business) in more advantageous or profitable advertising. The Electric Sign makes your store front brilliant, familiarizes the public with your name or business, attracts attention and draws trade as surely as the magnet draws steel. It is
CHEAP AND EFFECTIVE ADVERTISING
Let us ask you, how much newspaper, circular or postal card advertising you could get for five dollars a month—for ten dollars a month? Yet you can secure an Electric Sign for this and there is no better means of keeping your name before the public, day and night. It will make your place stand out from the other stores on the block, by the aid of brilliant, cheerful light and cannot fail to do business for you.
The Electric Sign has already proved the best paying advertisement for hundred of merchants in Brooklyn, increasing their busines by from ten to one-hundred per cent. Then why not for you?
ROSBACH
NATURAL SPARKLING
TABLE WATER

FIG. 6.—THIS KIND OF PRINTING SELLS ELECTRICITY.

Fig. 7 is the cover page of a little magazine issued monthly by the United Electric Light and Power Company, New York city. This magazine contains brief sketches concerning the use of electricity in the home, shop and office, and its relation to health, happiness and economy. This magazine is in booklet form and measures three and one-half by four and three-quarters inches. It contains eight pages and the cover, which is printed in brown and black on white stock.

Fig. 8 is a reproduction of a cover page of a booklet from the Edison Electric Illuminating Company, Boston, Mass. As is indicated in the title, this eight-page booklet is replete with instruction and illustrations concerning the methods of charging for current. This takes up in detail instruction for reading the meter, shows how to determine the amount of current consumed during a given period, how to determine the lamp-hours, details the indicators, the office of the indicators, describes the class of customers and gives examples of various charges. The booklet measures four by eight inches, and the cover is in imitation organdie, printed in red and black with gold illumination and stitched with a red silk cord. Outside of the practical value of this booklet it is

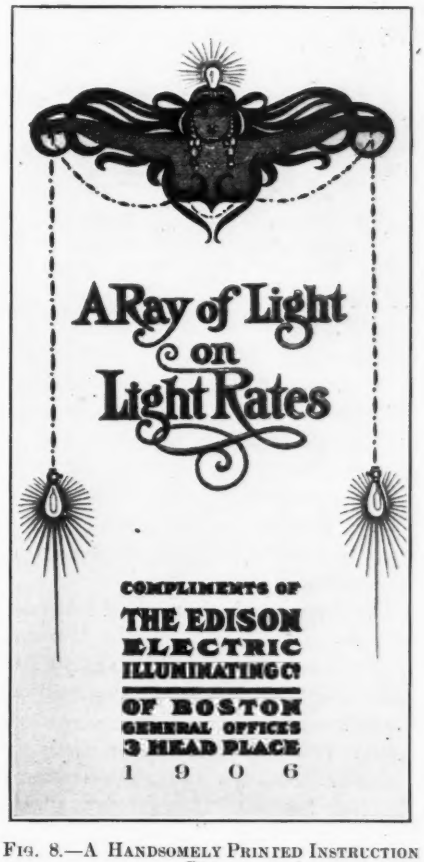


FIG. 8.—A HANDSOMELY PRINTED INSTRUCTION BOOK.

one of the handsomest pieces of literature that we have seen for some time.

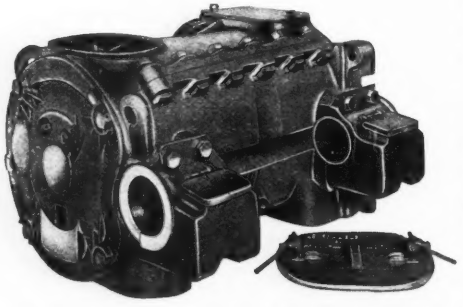
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

General Electric Single-Phase, Alternating-Current Railway Motor.

Great interest is being manifested in single-phase, alternating-current apparatus throughout engineering circles, and following is a brief description of the General Electric single-phase motor which has met with much success in traction service. For this class of work the General Electric Company furnishes a complete line of alternating-current, single-phase railway motors, including sizes of 75, 125 and 200 horse-power, respectively. These various motors embody the same constructive principles as the first mentioned, the GEA 605 (seventy-five horse-power) type, about to be described.

In general, this motor is built with the same regard for constructive detail which characterizes the General Electric direct-current railway motor. The magnet frame is split and bolted together so that the armature may be readily accessible, and to further the ease of handling bails are cast into the frame. Provisions for ventilation and inspection of the interior of this motor are quite complete. The opening over the commutator is closed with an iron cover with a felt gasket and the cover is held in place by an adjustable cam-locking device.



GENERAL ELECTRIC SINGLE-PHASE ALTERNATING-CURRENT RAILWAY MOTOR.

The frame heads are made of malleable iron cast in one piece. In order to secure large and long bearings without sacrificing other desirable features of construction, the heads are made conical in shape and extend under the commutator shell and pinion-end armature core head. This construction forms a support for the bearing linings, which is very strong and rigid. The frame head castings have large oil wells, into which oily wool waste is packed and comes in contact with a large surface of the armature shaft through an opening in the low-pressure side of the bearing linings.

The linings are unsplit bronze sleeves, finished all over, with a thin layer of babbitt metal soldered to the interior bearing surface. The babbitt furnishes an ideal bearing surface and is so thin that it will not allow the armature to rub on the poles in case it is melted out by overheating. Oil is prevented from entering the interior of the motor by oil deflectors, which throw it into large grooves cast in the heads, from which it is then conducted away. This form of bearing is fully equal in simplicity and reliability to the standard M. C. B. journal bearing.

The armature coils are wound on accurately shaped forms and pressed to exact shape in steam moulds, with insulation between adjacent coils. Each coil is carefully insulated with mica, enabling the armature to stand a high temperature without injury, and the armature bars are soldered directly into the commutator ear.

The commutator is constructed of segments of hard-drawn copper, insulated throughout with the very best grade of mica. The cone micas are built up and pressed hard and compact in steam moulds. The segment mica is made of a somewhat softer quality, with the view of making it wear down evenly with the copper. Much care is taken in the construction of the commutator. The coned surfaces are machined with extreme care and cleaned to prevent possible short-circuits, while the creepage distances are made long to prevent grounding. The commutator shell and cap are made of cast steel and these parts are extremely strong. The segments are clamped very tight and the cap is pressed down securely in an hydraulic press before tightening the commutator nut.

The brush-holders, four in number, are made of cast bronze and have two carbon brushes per holder. The brushes slide in finished ways and are pressed against the commutator by independent fingers, which give a practically uniform pressure throughout the working range of the brushes. The arrangement of the springs actuating the fingers is such that there is but slight pressure on the pins on which the fingers pivot. This prevents any tendency of the fingers to stick on the pins and reduces the wear to a minimum.

There is a "pigtail" or shunt between the fingers and the brush-holder body to prevent current passing through the springs or pivoting pins. The brush-holders are adjustable to allow for wear of the commutator. They are clamped on mica-insulated studs, sliding in finished supports which are bolted to the frame. This method of insulating brush-holders was developed by the General Electric Company some years ago and has been applied to all modern types of G. E. motors with marked success. There is a great advantage in using the highest quality of insulating material which is not injuriously affected by heat or moisture.

The motor field consists of annular laminated punchings assembled into a cylinder, and contains the exciting and compensating windings. The compensating winding consists of mica-insulated bars inserted in partly closed slots in the face of the polar projections; all the bars being connected in series and the whole connected permanently in series with the armature at the motor and the two elements are treated as a single unit.

The exciting winding consists of coils similar to the field coils of a direct-current motor and may be removed as a unit, as is customary in direct-current motors; that is, the spool surrounds a projecting pole-piece.

The seventy-five-horse-power motor is wound for four poles and has four brush studs, while the 125-horse-power motor is wound for six poles and has six brush studs. The compensating winding is connected permanently in series with the armature and the exciting windings are connected in series with these at the controller, or commutating switch, where the change is made for reversing the direction of the motors and for changing the connections when desired to change from alternating current to direct current.

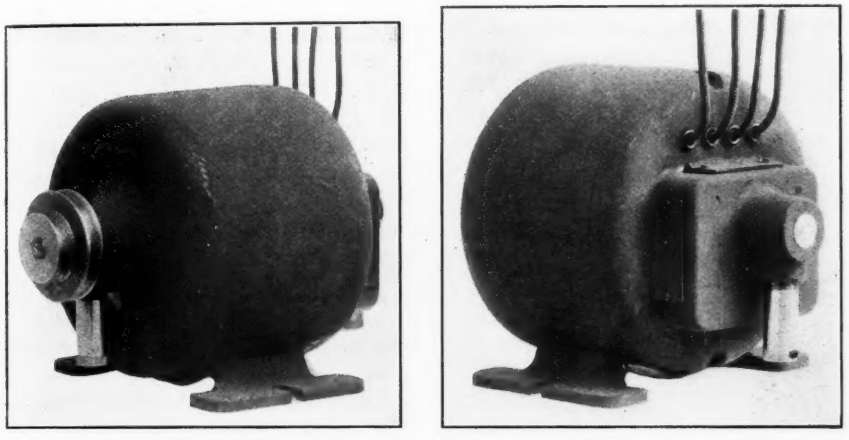
It will be noted from the above description of these motors that the most approved forms of mechanical and electrical construction, as embodied in the modern types of direct-current railway motors, have been followed. The armature speeds are relatively low, ensuring good commutation and absence of bearing troubles.

For the control of these motors the General Electric Company has developed suitable hand controllers for single-car operation and Sprague-General Electric type M control for operation of cars in trains. The controlling apparatus is extremely simple, whether equipments are to be operated on alternating current alone or on

both alternating and direct-current circuits. As in most instances it will be necessary to operate alternating-current equipments over existing direct-current trolley lines, particular attention has been paid to simplifying the equipment for both alternating-current and direct-current operation, with the result that equipments of this type are practically automatic in changing over from one system to the other and can be handled by inexperienced motormen with entire success. We will be able to publish further details of this controller at a later date.

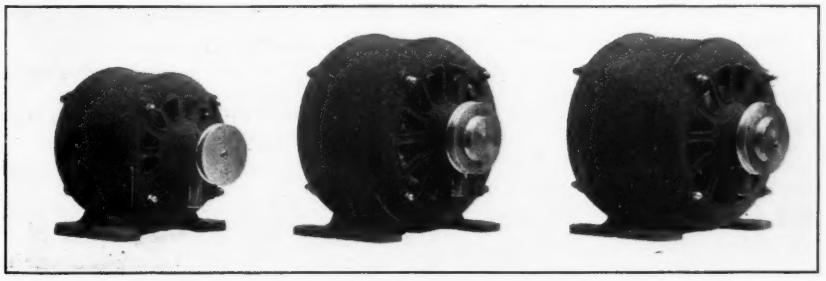
Small Power Motors.

The Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., has lately perfected a line of motors for light-



ONE-EIGHTH-HORSE-POWER DIRECT-CURRENT, 110-VOLT MOTOR, SHOWING BACK-ENDS OF MACHINE.

power service, such as operating sewing machines, dental apparatus, coffee grinders, small ice-cream freezers, phonographs, sign flashers, moving window novelties and hundreds of other adaptations. The smaller sizes may be attached to an ordinary incandescent lamp circuit, furnishing a profitable day load for lighting companies.



ONE-EIGHTH, ONE-TWELFTH, AND ONE-TWENTIETH HORSE-POWER INDUCTION MOTORS.

These motors follow very closely the design of the well-known Westinghouse fan motors; they are built for both alternating and direct-current circuits, either 115 or 230 volts. The direct-current motors are either shunt or series wound and the alternating-current motors are wound for 25, 60 or 133 cycles. The efficiency of all machines is exceedingly high.

The base of the motor consists of a separate casting, the frame being drilled and tapped so that the feet may be fastened in any one of four different positions. This construction adapts the motor for mounting in any position. The screw holes in the base are slotted to allow belt adjustment. A two-step grooved pulley, suitable for a cord or round belt, is supplied with each motor. The speed obtained by driving from the larger step is about twice that of the smaller.

The bearings are self-oiling and similar in construction to those of the fan motors. They are provided with vertical oil-cups with a wick which effectually lubricates the shaft, and a suitable return channel prevents the dripping of oil from the bearings. The leads are brought out through hard rubber bushings and connection to the motor is easily made. An ordinary lamp cord and plug may be attached to the motor leads for connecting it to an incandescent socket or receptacle.

All motors are finished in black enamel with the trimmings of brass, allowing them to be installed where neat appearance is essential.

The alternating-current motors are of the single-phase induction type with open-end frames and split-phase winding, the starting coil of which is automatically cut out as the motor comes up to speed. A self-acting friction clutch engages the load after partial speed has been attained. The direct-current motors are enclosed and are supplied either series or shunt wound, and are so constructed that no starting device is necessary.

When desired, grooved pulleys of other sizes are furnished.

The "Can't-Break" Lamp Guard.

The Benjamin Electric Manufacturing Company, Chicago, Ill., has added another specialty to its list of electrical devices by introducing the "Can't-Break" lamp guard. A study of the accompanying illustration will demonstrate the simplicity, strength and durability of the device and show that, together with a minimum light reduction, it meets the requirement of a lamp guard by offering a lamp protection which is complete.

LAMP GUARD, OPEN.

LAMP GUARD, ATTACHED.

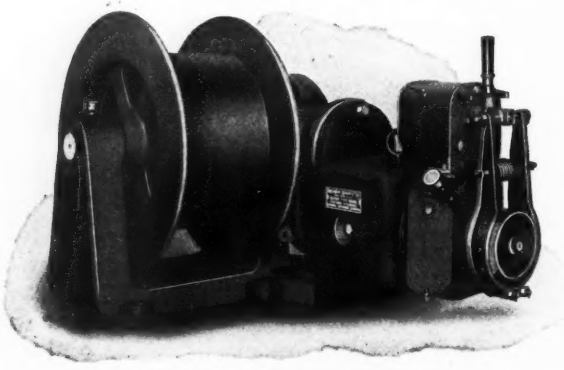
The "Can't-Break" consists of two halves, each pressed up from sheet steel. There is no solder to break or wire to give way. It has comparatively few joints.

There are but two hinge joints at the top and two locking joints at the bottom. The two parts with hinge joint at the top grip the bead on the socket firmly, thus secure fixedness and stability and render all refractory and arbitrary wabble and unsteadiness impossible. This precludes grounding the lamp.

An auxiliary spring wire centres the lamp, cushions it gently and keeps it from striking the main body of the guard. The sheet steel forming the guard is pressed up edgewise radially. It is tinned and bright. There is consequently little shadow and the loss of light is thus reduced to a minimum. It protects the whole lamp, including the tip; no part is left exposed to breakage. It is easily removed and easily readjusted.

Winding Drum Hoists.

The Sprague Electric Company, New York, N. Y., manufactures several styles of electric-winding drum hoists which are meeting a popular demand. One of the most recent types is shown in the accompanying illustration. Hoists of this style require to be fastened securely to a foundation when in use, but they can be mounted upon a movable platform, truck or car, and thus be made portable between hoisting operations. They are used on boom derricks for raising both the load and the boom; as whip hoists; to raise loads rapidly through a hatchway, or in the open, and on docks, on board ships or in buildings. They can be used out-of-doors without protection from the weather as they are entirely enclosed and are dust and moisture-proof. The controller, shown on the hoist motor, can be located in any desired position regardless of the location of the hoist, thus affording the utmost convenience in operation.

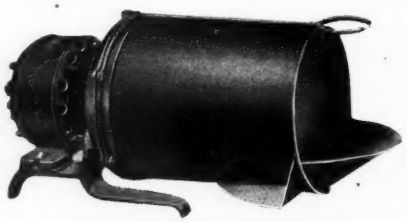


Motor Driven Winding Drum Hoist.

Standard winding drum hoists are rated for single rope with maximum pull of one-half, one and one-half and two and one-half tons. By multiplying the number of ropes, correspondingly increased loads can be worked at reduced speeds.

A Self-Contained Apparatus for Ventilating.

The accompanying illustration shows a device designated as "Cleanairs," invented by John W. Fries, Winston-Salem, N. C., for regulating and controlling the atmospheric conditions in a close room. The apparatus consists of a metal cylinder and a fan driven by a small motor. The fan creates a suction of air into the opposite end of the cylinder, draws the air in a circular motion directly over a pool of water held in a small basin in the bottom of the cylinder, and discharges the air into the room through an opening shown at the side. In passing through this device the air evaporates the water held in the basin, discharging a cool, moist current of air into the room, and at the same time causing good circulation.



Ventilating Apparatus.

Moisture may be extracted from the air by placing a quantity of odorless calcium chloride or other hygroscopic material in the basin instead of the water. The chloride, being very hygroscopic, absorbs moisture from the air, which is then discharged into the room in a comparatively dry condition.

Dust and dirt which may be present in the air are caught by the water in the basin as the air passes over it, allowing the air to leave the machine in a fresh, clean condition.

The machine may be connected to the electric light wires and placed on a shelf, table or desk. The basin is easily filled with water, and all that is necessary in starting the apparatus is to turn on the switch.

Trolley Companies May Carry Freight.

The New Jersey legislature has passed a bill permitting trolley companies to carry freight and a limited franchise measure granting leases to public utility companies for a period of twenty years.

Large Gifts to Institute Building Fund.

The chairman of the land and building fund of the American Institute of Electrical Engineers announces this week some large and important contributions to this fund, the object of which is to raise $200,000 for the land on which the United Engineering Building, given by Mr. Carnegie, is now being erected. The total cost of the land is $540,000, and the obligation is divided between the electrical, mechanical and mining engineers.

Mr. Clarence H. Mackay, president of the Postal Telegraph-Cable Company, has given $5,000 to the fund, accompanied by the expression of his interest in the building as a centre whose facilities will be available to the various bodies of telegraphers. Mr. U. N. Bethell and Mr. J. J. Carty, members of the committee, have advised it, on behalf of the American Telephone and Telegraph Company, the Western Electric Company, the New York & New Jersey Telephone Company and the New York Telephone Company, that these corporations have jointly contributed $25,000 to the fund, in view of the great benefits that the existence of this new engineering centre will confer upon the electrical arts and upon their employés in the widening field of telephone engineering.

Other notable gifts to the fund are $1,200 from Mr. E. W. Rice, Jr., and $500 from Mr. T. D. Lockwood. A number of subscriptions of lesser amounts have been received from the Institute membership at large, and in this manner the fund has now reached the total of over $130,000, or two-thirds of the required amount. With the campaign it has already inaugurated and the plans now maturing, the committee is hopeful of having the entire sum pledged before the Institute moves into its new home.

A Boston Branch of the Illuminating Engineering Society.

A number of the Boston members of the Illuminating Engineering Society, which was recently organized in New York city, have announced an informal meeting at the American House, Boston, Mass., March 20, at 7.30 P. M. This is for the purpose of talking over the best methods to pursue in the formation of a Boston branch of the society. Those taking the initial step in this direction are Dr. Louis Bell, Charles B. Burleigh, J. S. Codman, W. W. Cummings, John Campbell, Charles J. Hatch, R. S. Hale, H. C. Jones and W. D'A. Ryan.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NIAGARA FALLS ELECTRICAL TRANSMISSION COMPANY TO INCREASE CAPITAL STOCK—The state gas and electricity commission has granted the application for increase of capital stock made by the Niagara Falls Electrical Transmission Company. The increase is to be from $100,000 to $3,500,000.

PITTSBURG & BUTLER TROLLEY LINE TO BE EXTENDED TO CLEVELAND, OHIO—Plans are being made to extend the new Pittsburg & Butler (Pa.) trolley line, which is expected to be in operation in the spring, to Cleveland, Ohio. This will make a short line between the two cities. The new road is being equipped for heavy traffic, including high-power motors and the catenary system of overhead construction. The motors will be of the single-phase type.

ELECTRIC ROAD IN CANADA—It is announced that Senator Domville, who recently left Montreal, Canada, to secure assistance in England for the building of a new electric road from Montreal to Ottawa, has been successful in forming a syndicate to undertake the construction of the Canada Central Railroad, formerly known as the Ottawa Valley Railroad. The line will run from Montreal to Ottawa, and thence on to the Great Lakes. It will be operated entirely by electricity.

HYDROELECTRIC COMPANIES COMBINE—The United Hydroelectric Company, in which are merged the United Light and Power Company, the Cascade Electric Company and the Green & Clear Lakes Water Storage Company, Idaho Springs, Col., has been formed. The new company is capitalized at $500,000, of which $200,000 is preferred stock and $300,000 common stock. No change in the management occurs, J. J. Sherwin remaining president; W. L. Bush, vice-president; F. P. Dewey, secretary-treasurer, and H. L. Corbett, manager.

THE MONTANA INDEPENDENT TELEPHONE COMPANY—The Montana Independent Telephone Company, with a capitalization of $2,000,000, has been launched, and the city council of Butte, Mont., has been asked for a franchise. The capitalists interested are F. Augustus Heinze, Charles R. Leonard, Charles J. Kelly, D. J. Hennessy, H. A. Galloway, Henry Muhler, Herbert B. Brown and Elmer B. Jones. F. W. Moss, of Billings, president of the First National Bank of that place and also chief executive of the Independent Telephone Company, of Billings, is a member of the organization. Mr. Jones is managing director of the Utah Independent Telephone Company, and it was he who put through the organization.

CONSOLIDATION OF SPOKANE (WASH.) RAILWAYS—Jay P. Graves, of Spokane, Wash., who has been identified with several of the railway and traction properties in and around Spokane, has effected a consolidation of those in which he has been mainly interested. Among the roads which have been consolidated into one system are the Spokane & Inland, the Spokane & Coeur d'Alene, the Spokane Traction Company and the Spokane Terminal Company. The Spokane & Inland is under construction, and runs southeast from Spokane into Palouse county. It is projected for a distance of 140 miles, part of which is under construction. The Spokane Traction Company has about thirteen miles of street railroad in Spokane. It receives its power from the Washington Water Power Company, which also supplies power to the Spokane & Inland Railroad.

POWER PLANT AT THE BLACK RIVER FALLS, WIS.—Preparatory work for the power dam to be built on the Black river, a few miles above Black river falls, Wis., is being rapidly undertaken. A large corps of men is now clearing the 1,000 acres that will be flooded. The wood is being taken off, and the land will be left clear for the lake, which will be from one-half to three miles wide and five miles long. Work on the dam will begin as soon as spring opens. The dam will be nearly half a mile long and forty-seven feet high, and will be of solid concrete. It will give a fall of ninety feet, and will develop 12,000 horse-power. This will be transmitted to La Crosse, and it is also intended for the new electric railroad. It is expected that a pottery works will be established to utilize the kaolin deposits which abound in the neighborhood.

HYDROELECTRIC DEVELOPMENT ON THE MISSISSIPPI RIVER—Plans for the construction of a hydroelectric power station capable of generating 25,000 horse-power have been definitely decided upon by the Great Northern Development Company, of Duluth, Minn., of which C. C. Cokefair is president. The work will be undertaken on the Mississippi river at the village of Otsego, near Elk river, and will represent an investment of between $3,000,000 and $4,000,000. Construction work will begin in the spring, and the plant will be completed and power delivered to the cities of St. Paul and Minneapolis within the next twelve months. The deal comprehends the acquisition by the development company of the entire capital stock, lands, riparian rights, franchises and other assets of the Minnesota Power and Trolley Company, which was organized a few years ago by Joseph Kiichli and associates.

MAHONING VALLEY & SHENANGO RAILWAY AND LIGHT COMPANY ORGANIZED—A meeting of the directors of the Mahoning Valley & Shenango Railway and Light Company was held at Newcastle, Pa., on Friday, February 23, at which time final action in connection with the merging of the properties of the Pennsylvania & Mahoning Valley Railway Company and the Youngstown-Sharon Railways and Light Company was taken, and the merger became effective. The following officers of the company were elected: president, E. N. Sanderson; first vice-president, Randall Montgomery; second vice-president, M. E. McCaskey; treasurer, Alexander S. Webb, Jr.; secretary, Leighton Calkins. The merged interests in the capital stock of the new organization represent an investment of $10,000,000, and control and operate between 150 and 170 miles of street railways, besides electric lights in Youngstown, Ohio, and Newcastle and Sharon, Pa.

A NEW TRACTION CORPORATION FOR CHICAGO—It is announced that a corporation with a capital stock of $50,000,000 is to be incorporated in New Jersey to construct one of the largest interurban systems in the world for Chicago, Ill., and the territory to the south, southeast and southwest of that city. Entrance to Chicago is to be by an elevated structure built over the tracks of the Lake Shore and Rock Island railroads, and the main station will be at the corner of La Salle and Van Buren streets, Chicago. Access to Chicago from all points in northern Indiana and northern Illinois, with the possible extension of the system to Indianapolis and St. Louis, is contemplated. In addition a system of electric lines interlacing the whole of this territory and furnishing connections with every part is projected. The name of the new corporation will be the Chicago Elevated Interurban Terminal Traction Company. The cost of building the entire system is estimated at $6,235,500, and it is to be completed in three years.

CENTRAL NEW YORK TELEPHONE AND TELEGRAPH COMPANY APPROPRIATES $2,000,000 FOR IMPROVEMENTS—An important meeting was held at Utica, N. Y., on February 17 by the Bell Telephone interests, resulting in the appropriation of $2,000,000 for improvements to the system and service of the company. Closely following the expenditure of several thousands of dollars in improving the system in Utica and the near-by towns, the stockholders and directors of the Central New York Telephone and Telegraph Company voted a further appropriation of $2,000,000 to be expended in building additional subways, making additions to the cable and aerial plant, and generally improving the system and the service. The stockholders' annual meeting was held shortly after noon at the company's office, and outside of the election of officers and the regular routine business nothing of public interest was transacted, excepting the $2,000,000 appropriation. At the previous annual meeting $1,500,000 was appropriated to be expended throughout the territory, and of this sum over $50,000 was spent in Utica in subways, additional switchboard sections and aerial and cable work. The $2,000,000 will be expended in the large territory which is operated by the Central New York and the Empire State companies. The stockholders elected the following directors: U. N. Bethell,

New York; Charles F. Cutler, New York; Frederick G. Fincke, Frederick T. Proctor, Joseph Rudd, George L. Bradford, J F. Maynard, Charles B. Rogers and F. G. Wood, Utica; Thomas Sherwin and Frederick P. Fish, Boston; H. F. Stevens, Syracuse, and S. M. Greer, New York. At a subsequent meeting the directors elected Charles F. Cutler, chairman; U. N. Bethell, president; H. F. Stevens, vice-president, and F. G. Wood, secretary and treasurer. Mr. Stevens, the new vice-president, is general manager of the Central New York Telephone and Telegraph Company, which operates in central New York; of the Empire State Telephone and Telegraph Company, operating west and south of Syracuse; and of the New York & Pennsylvania Telephone and Telegraph Company, which operates in the southern tier and in Pennsylvania. Mr. Stevens is located at Syracuse, which is the general headquarters for the three companies. The annual meeting of the stockholders of the Empire State Telephone and Telegraph Company was held at Auburn, N. Y., on February 16, and the following directors were elected: Frederick G. Fincke, Utica; Charles I. Avery, Auburn; Charles F. Cutler, New York; Frederick P. Fish, Boston; Henry L. Storke, Auburn; U. N. Bethell, New York; H. F. Stevens, Syracuse; Thomas Sherwin, Boston; George Underwood, Auburn. The following day the directors met in Utica and organized as follows: Charles F. Cutler, chairman; U. N. Bethell, president; H. F. Stevens, vice-president; F. G. Wood, secretary and treasurer.

OBITUARY NOTICES.

MR. J. ALBERT KELLY, an inspector in the Electrical Bureau, Philadelphia, Pa., died on March 5 at his home in Philadelphia. He had been connected with the bureau since February 14, 1891.

MR. WILLIAM WINSLOW AMES died on March 7 at Montclair, N. J., after a long illness. He was for several years engaged in electrical engineering in New York and Brooklyn, and was one of the organizers of the Montclair Electric Light Company. Mr. Ames was active in public matters, a director of the Young Men's Christian Association and a member of the Montclair Club.

MR. JAMES PARTRIDGE, manager of the Sandusky (Ohio) works of the National Carbon Company, Cleveland, Ohio, died suddenly at the carbon works on the morning of Saturday, March 10. Death was caused by an aneurism of the heart. Mr. Partridge was born in Birmingham, England, in 1854. In 1890 the Partridge Carbon Company was organized, and when this company was purchased by the National Carbon Company, in 1899, Mr. Partridge was retained as manager of the Sandusky plant. He is survived by a widow and two sisters.

NEW INCORPORATIONS.

FARGO, N. D.—The Pingree Telephone Company. $50,000.

LINCOLN, NEB.—Pleasant Dale Mutual Telephone Company. $650.

CONCORD, N. H.—Franklin Gas and Electric Company. $200,000.

BUNKER HILL, KAN.—Bunker Hill Telephone Company. $12,000.

HAZELTON, PA.—Consumers' Electric Light and Power Company. $25,000.

SPRINGFIELD, ILL.—Windsor Mutual Telephone Company. Increased from $2,500 to $5,000.

COLFAX, ILL.—Colfax Telephone Company. $15,000. Directors: William Gaddis, J. P. Arnold and E. J. Harris.

FARGO, N. D.—Citizens' Telephone Company. $50,000. Incorporators: F. E. Corson, C. D. Corson and E. N. Corson.

SUPERIOR, WIS.—Northern Power Company. $25,000. Incorporators: W. M. Steele, C. R. Fridley and Frank McCormick.

TOPEKA, KAN.—Mineola Indian Telephone Company. To operate in Clark, Meade, Ford, Kiowa and Comanche counties. $2,000.

FISHERS SWITCH, IND.—Highland Telephone Company. $2,000. Directors: Claude Beaver, W. Beaver, C. Sachs, Thomas McCarty.

ALBANY, N. Y.—The Lapeer Telephone Company, Lapeer. $2,000. Incorporators: L. C. Parker, E. E. Hults, W. B. Lusk, Marathon.

LINNEUS, MO.—Linneus Rural Telephone Company. $5,000. Incorporators: John L. Stephens, J. M. Griffith, W. R. Peacher, W. Brown.

YUMA, ARIZ.—Moneta Avenue Water and Lighting Company. $1,000,000. Incorporators: William H. Fuller, J. M. McLeod and Paul Winston.

CAMDEN, N. J.—Consolidated Gas and Electric Company. $10,000. Incorporators: Henry L. Chew, Norman Grey and Wilfred B. Wolcott.

SPRINGFIELD, ILL.—Elm Grove Mutual Telephone Company, Rose township. $2,450. Incorporators: Lewis T. Lipkey, Michael N. Reinhart, Michael Ruch.

SALEM, MO.—Salem Telephone Company. $3,000. Incorporators: M. E. Bruce, Thomas A. Bruce, T. Russell, Wallace McDonald and Bessie I. Reid.

BURLINGTON, OHIO—North Kenova Telephone Company. $1,800. Incorporators: Amaziah Winters, E. W. Elkins, J. H. O'Neill, O. M. Elkins and F. M. Fullerton.

COLUMBUS, OHIO—The North Star Telephone Company, of Darke county. $20,000. Incorporators: J. D. Hartzell, Lewis J. George, W. A. Roll, Job Goslee and H. G. Burns.

GUTHRIE, OKLA.—The Pleasant Valley Telephone Company, of Jet. $1,200. Incorporators: H. O. Reeves, W. S. Hockenberry, W. L. Blackledge, W. W. White and Calvin Jones.

TOPEKA, KAN.—Benton Telephone Company, Hodgeman county; $1,000. People's Water, Light and Power Company, Hutchinson; $50,000. Assaria Mutual Telephone Company, Assaria; $6,000.

CUTLER, IND.—Cooperative Telephone Company. $4,000. Directors: William H. Draper, Noah Plank, William Smith, George Phillips, W. S. Hazlett, George W. Shanklin, James D. Love.

COLUMBUS, OHIO—The People's Telephone Company, of Sardinia, Brown county. $5,000. Incorporators: G. U. Kennedy, F. H. Slaughter, C. W. Frazier, M. E. Campbell, A. L. Weisbrodt, J. S. Plummer and F. L. C. Weisbrodt.

TRENTON, N. J.—The Prairie Telephone Company. To construct and operate telephone lines outside of the state. $200,000. Incorporators: James A. Plotner and C. M. B. Chase, both of Kansas City, and Fred H. Brown, of Parsons, Kan.

OKLAHOMA, OKLA.—The Home Telephone Company, of Thomas. $20,000. Incorporators: J. F. Gully, W. L. McClung, A. H. Donnell, U. G. Wise, William J. Orner, Henry Helzer, S. H. McKnight, W. E. Rogers, J. G. E. Moser, A. H. Fansler and Earl Manning.

MEMPHIS, TENN.—Corinth & Shiloh Electric Railway Company. To build an electric road from Corinth to the Tennessee river and Shiloh park. $250,000. Officers: president, Abe Rubel; vice-president and manager, W. J. Lamb; secretary, M. T. Bynum.

ST. LOUIS, MO.—The Mascoutah & Belleville Railroad Company. To construct an electric road between Belleville and Mascoutah, and later extend it to Fayetteville and St. Libory. $100,000. Incorporators: George Postel, E. H. Hagiss, John Fackt, Peter V. Lill and Julius Postel.

PORTLAND, ME.—American Public Utilities Company. Organized at Portland for the purpose of building, operating and maintaining railroads and electric lighting plants. $3,000,000. Officers: president, Millard W. Baldwin, of Portland; treasurer, James J. Hernan, of Portland.

LITTLE ROCK, ARK.—The Harrisburg Electric Light and Power Company. $25,000, of which $2,550 is subscribed. Incorporators: A. A. Boon, Thomas Flournoy, J. C. Gant, M. H. Frayser, Dr. J. C. Davis, Morris Haynten, Thomas D. Steele, D. F. Cottle, J. A. Durham and Lee Woods.

DES MOINES, IOWA—Des Moines, Winterset & Creston Electric Railway Company. Officers: W. D. Skinner, president, Des Moines; J. H. Mack, vice-president, Macksburg, Iowa; A. E. Park, general manager, Des Moines; S. D. Alexander, treasurer, Winterset, Iowa; Milo Ward, secretary, Des Moines; N. E. Coffin, of Des Moines, general counsel.

PERSONAL MENTION.

MR. DUDLEY HOLLAND has been appointed manager by the Pacific States Telephone Company for Linn and Benton counties, Ore.

MR. C. E. F. AHLM, Williamson Building, Cleveland, Ohio, has been requested to prepare plans and specifications for the proposed municipal electric lighting plant for South Brooklyn, Cleveland, Ohio.

MR. W. N. ZURFLUH, superintendent of the Home Light, Power and Heating Company, Springfield, Ohio, has resigned. He will be succeeded by F. B. Greenwood, formerly with the Central Union Telephone Company.

MR. W. J. FERRIS, formerly at the head of the Edison Electric Illuminating Company, of Springfield, Ill., is now stationed at Champaign, Ill. Mr. Ferris has been appointed assistant manager of the Illinois Traction System.

MR. S. A. WILLIAMS has been appointed manager of the Jacksonville (Fla.) Electric Company, relieving Mr. W. H. Tucker. Mr. Tucker leaves Jacksonville to go to Dallas, Tex., where he will take charge of a street car system in that city.

MR. J. V. FISK, manager of the Beaumont (Tex.) exchange of the Southwestern Telegraph and Telephone Company, has been appointed manager of the Greenville (Tex.) exchange. Mr. Fisk has been succeeded by Mr. F. D. Newton, of the Michigan Telephone Company, Bay City, Mich.

MR. H. H. CLOUGH has retired from the general managership of the Rockford, Beloit & Janesville Railway, Janesville, Wis. Mr. Clough has returned with his family from a trip to the Bermuda islands, and his plans for the future are not settled, though he will go to Elyria, Ohio, for the present.

CAPTAIN W. L. CANDEE, manager of the Okonite Company, and Mrs. Candee returned last week after a two months' tour in Great Britain and the Continent. Mr. L. G. Martin, who has been superintending the laying of Okonite cables in China and Japan, met Captain Candee in London and returned with him.

LEGAL NOTES.

UNDER-RUNNING TROLLEY CASE—In the under-running trolley case, involving the Van Depoele reissue patent No. 11,872, the Thomson-Houston Electric Company, complainant, *versus* Henry Holland, *et al.*, defendants, Judge Tayler has filed an opinion in the United States Circuit Court, Northern District of Ohio, Eastern Division, February 20, allowing the motion for a preliminary injunction.

EDGEWISE CIRCUIT-BREAKER CASE—An opinion has been filed in the United States Circuit Court of Appeals, Third District, February 27, 1906, in the edgewise circuit-breaker case of the Westinghouse Electric and Manufacturing Company, complainant appellant, *versus* the Cutter Electrical and Manufacturing Company, defendant appellee, reversing the decree of the circuit court, and the case is remanded to that court with instruction to enter a decree in favor of the complainant upon claims 2 and 5 of the patent in suit, in accordance with views expressed in the opinion.

REIST SPACE BLOCK CASE—In the Reist space block case, involving patent No. 508,637, the General Electric Company, complainant, *versus* the Bullock Electric Manufacturing Company and George Bullock, defendants, Judge Thompson filed an opinion in the United States Circuit Court for the Southern District of Ohio, Western Division, on February 19, concluding that the evidence shows that the defendant company's construction No. 1 infringes claims 1, 2, 4, 5 and 8, and that its construction No. 2 infringes claims 2, 4 and 6. No case is made against the defendant George Bullock. The court orders a decree for the complainant.

TESLA SPLIT-PHASE MOTOR—In the Tesla split-phase motor suit between the Westinghouse Electric and Manufacturing Company, complainant, and the Diamond Meter Company, defendant, involving patents No. 511,559 and No. 511,560, an interlocutory decree has been filed in the United States Circuit Court for the Southern District of Illinois, Northern Division, February 17, adjudging the patents involved good and valid in the law, entitling the complainant to the exclusive right in and to each of the letters-patent, and the defendant company is adjudged infringing certain claims. It is further adjudged that the complainant has a right to cause an examination to be made of the defendant's properties, and that an injunction be issued against the defendant restraining it or its servants from using the invention involved.

ELECTRICAL SECURITIES.

The hope entertained last week of a recovery in security prices has been pretty well fulfilled, the activity developing strongly during the last few days of the week. The net price changes for the week show that the recovery has been very general, and has included some advances of considerable significance. A small improvement in the commission business is also noticeable, and there is a widespread hope of a decided improvement all along the line.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MARCH 10.

New York:	*Closing.*
Allis-Chalmers common	22
Allis-Chalmers preferred	58
Brooklyn Rapid Transit	82⅜
Consolidated Gas	152½
General Electric	169¼
Interborough Rapid Transit	229
Kings County Electric	200
Mackay Companies (Postal Telegraph and Cable) common	60½
Mackay Companies (Postal Telegraph and Cable) preferred	74¼
Manhattan Elevated	156½
Metropolitan Street Railway	115⅜
New York & New Jersey Telephone	154
Western Union	93¼
Westinghouse Manufacturing Company	185

The trustees of the Mackay Companies have declared the regular quarterly dividend of 1 per cent on the preferred stock, payable April 2.

General Electric directors have declared the regular $2 quarterly dividend, payable April 16 to stockholders of record March 17. Books do not close.

The guaranteed quarterly dividend of 1¾ per cent on the stock of the Manhattan Railway Company is payable April 2. Books remain closed from March 16 to March 28.

The directors of the Interborough Rapid Transit Company have declared the regular quarterly dividend of 2 per cent, payable April 2 to holders of the voting trust certificates of record March 19. Books close March 19 and reopen April 2.

Boston:	*Closing.*
American Telephone and Telegraph	138½
Edison Electric Illuminating	247
Massachusetts Electric	68
New England Telephone	136
Western Telephone and Telegraph preferred	91

Philadelphia:	*Closing.*
Electric Company of America	11¾
Electric Storage Battery common	79
Electric Storage Battery preferred	79
Philadelphia Electric	7⅞
Philadelphia Rapid Transit	31½
United Gas Improvement	94½

Chicago:	*Closing*
Chicago Telephone	120
Chicago Edison Light	158
Metropolitan Elevated preferred	68
National Carbon common	95
National Carbon preferred	122½
Union Traction common	12¾
Union Traction preferred	40

Official notice of the 15 per cent increase in the capital stock of the Chicago Edison Company has been sent to the stockholders. Under the terms of the resolution ordering the increase stockholders of record April 21 will be entitled to subscribe at par for new stock equal to 15 per cent of their holdings of the present issue. Subscriptions and amount of the first instalment must be sent to the company's office on or before May 1. Payments for the new stock will be made in four instalments of 25 per cent each, on May 1, August 1 and November 1, 1906, and February 1, 1907. For the purposes of this stock issue the transfer books of the company will close April 21 and reopen May 2. The new stock is part of the amount authorized by the stockholders in 1903, when the issue was increased to a possible $15,000,000. The amount of stock to be issued is nearly $1,800,000, and brings the company's total up to $13,600,000.

TELEPHONE AND TELEGRAPH.

HOUSTON, TEX.—A telephone line is being put up between Pearland and Riceton.

CAMDEN, N. J.—The new farmers' telephone line between Medford and Marlton has been completed.

DES MOINES, IOWA—The Bell Telephone Company is placing its wires in the conduits built last year in East Des Moines.

HAMILTON, OHIO—The Bell Telephone Company has completed a circuit from Hamilton *via* West Elkton and Jacksonburg.

SALT LAKE CITY, UTAH—The Utah Independent Telephone Company's line between Provo and Springville has been completed.

OAKLAND, CAL.—The Home Telephone Company will erect a new four-story building. This will be used as the permanent quarters of the company.

CHANUTE, KAN.—The Bell Telephone Company is completing thirty rural lines connecting farmers within a radius of from five to eight miles of Chanute.

HUNTINGTON, W. VA.—The Bell Telephone Company will shortly commence the building of a line from Huntington to Bluefield by way of Kenova and Twelve Pole.

KANSAS CITY, MO.—The Bell Telephone Company has completed its conduit system in the vicinity of Van Horn roadway, and will now remove all poles from the roadway.

RIFLE, COL.—At a meeting of the Cache-Beaver Creek Telephone Company officers were reelected as follows: J. B. Elrod, president; E. L. House, secretary; D. R. Harlow, treasurer.

CHICO, CAL.—The Sunset Telephone Company has completed arrangements for the establishment of an underground conduit system. The necessary franchise has been procured from the city council.

CORONA, CAL.—The Corona Home Telegraph and Telephone Company has commenced the erection of a brick office building. The new company is making rapid headway with the installation of its system.

PARK CITY, UTAH—The Utah Independent Telephone Company has opened its Park City exchange. The equipment, including a fireproof building, was installed at an expense exceeding $50,000, and is modern throughout.

CASPER, WYO.—The Wyoming Telephone Company, a corporation composed mostly of Casper men and which has been operating a ranch service throughout the state for several years, is now putting in a complete city service at Douglas.

CINCINNATI, OHIO—At the annual meeting of the Cincinnati & Suburban Bell Telephone Company the same board of directors was reelected. The company has decided to reduce the rates for measured service and also for slot-machine telephones.

BALTIMORE, MD.—The Chesapeake & Potomac Telephone Company has been awarded a contract by the Johns Hopkins University for the installation of a complete private branch exchange telephone system throughout the various buildings of the university. Twenty-seven stations will be installed.

BANGOR, ME.—The Postal Telegraph-Cable Company has completed a direct connection with the Northern Telegraph Company, adding 500 miles of pole line and 150 offices to the Postal system in northern Maine. Telegrams are now transmitted *via* Postal to the Moosehead lake region and all points on the Bangor & Aroostook Railroad.

LINCOLN, NEB.—The Farmers' Independent Telephone Company, of Thurston and Wayne counties, with headquarters at School District No. 2, in Wayne county, has filed articles of incorporation with the secretary of state. The capital stock of the company is $7,000, and the incorporators are Charles A. Killian, R. J. Chambers and others.

OMAHA, NEB.—The Nebraska Telephone Company will expend $115,000 this year in improvements in South Omaha. It will erect a new building, lay new cables in the underground conduits and buy new switchboards. Work on a new brick building will begin as soon as the weather will permit. The building will be 33 by 100 feet and either two or three stories high.

NEW YORK, N. Y.—Plans have been filed for remodeling the eight-story and basement exchange office building of the New York Telephone Company at 51 and 55 Franklin street. The operating quarters on the second, third, fourth and fifth floors are to be rearranged to afford more working space, and new plumbing is to be installed. The improvements are to cost $35,000, according to the estimate of Eidlitz & McKenzie, the architects.

WENATCHEE, WASH.—Many important changes are now taking place throughout the central part of Washington in regard to the telephone service. The town of Quincy and surrounding country, which has been without telephone service, will have two new lines. The Pacific States Telephone and Telegraph Company is about ready to string wires between Wenatchee and Quincy. W. H. Babcock, of Douglas and Chelan counties, will install a telephone system in Quincy, which will connect with the line now in use between Quincy and the Babcock ranch on the Columbia river. The Babcock system will connect with the Farmers' telephone line of Wenatchee, Cashmere, Malaga and Leavenworth, thus affording an excellent service from Leavenworth to Quincy, taking in most of the ranches between these two towns. The lines to the north through the Okanogan country are also being extended, and the towns in that district will soon be connected with long-distance systems.

ELMIRA, N. Y.—At the annual meeting of the stockholders of the New York State Telephone Company the following officers were elected: president, Edward Davis, Philadelphia; vice-president, Boyd McDowell, Elmira; secretary, Eugene Diven, Elmira; treasurer, E. M. Yarnell, Philadelphia; members of the board of directors, Frederick W. Swan, president; M. H. Murphy, Elmira; Eugene Diven, Elmira; Boyd McDowell, Elmira; Myer Friendly, Elmira; H. C. Mandeville, Elmira; H. N. Gett, Hanover, Pa.; S. L. Johns, McCherrytown, Pa.; the Hon. W. U. P. Thompson, Coatesville, Pa.; E. G. S. Reinhold, Mahanoy City, Pa.; Colonel C. M. Clement, Sunbury, Pa.; Edward Davis, Philadelphia; E. M. Yarnell, Philadelphia; T. B. Crary, Binghamton; William Fell, E. B. McKee, Charles L. Tracy, Towanda, Pa.; A. B. Greenshield, Philadelphia; the Hon. Ellis L. Orvis, Bellefonte, Pa.; E. M. Leader, Shamokin, Pa. Edward Davis, the new president, succeeds W. D. Bernard, who died last October at his home in Philadelphia.

NEW MANUFACTURING AND CONSTRUCTING COMPANIES.

ST. LOUIS, MO.—The J. G. Barr Electric Company has been incorporated with a capital of $10,000, fully paid. The incorporators are Jesse G. Barr, Wade H. Bush, Frank J. Daugherty, Ernst C. Krause and Marion E. Loftus.

INDIANAPOLIS, IND.—The Peru Common Battery Lockout Telephone Company has been incorporated with a capital of $7,000. The directors are Marke P. Boone, E. H. Griswold, Joseph Andres, John E. Yarling, Joseph M. Bergman, Jerome Herff and Louis B. Fulwiler.

ALLENTOWN, PA.—The Lehigh Electric Company has been incorporated by J. H. Jacoby, A. S. Weibel, J. S. Ritter and E. H. Frey. The capital stock is $10,000, with Mr. Jacoby as president. Mr. Weibel as secretary and treasurer, Mr. Ritter as manager and Mr. Frey as superintendent.

GREENSBORO, N. C.—The Central Electric Company, of Greensboro, has been chartered by the secretary of state. The capital stock is $25,000, of which $2,500 has been subscribed. The object of the company is to do a general electrical business. The incorporators are W. C. Waddell, C. W. Petty and C. E. Leak, all of Greensboro.

ENGINEERING SOCIETY.

AMERICAN ELECTROCHEMICAL SOCIETY—At a meeting of the board of directors of the American Electrochemical Society, held in Philadelphia, Pa., on March 3, the following were elected to membership: H. J. Williams, Philadelphia, Pa.; Henry Lacroix, Geneve, Switzerland; Samuel A. Tucker, New York, N. Y.; William H. Nichols, New York, N. Y.

ELECTRIC LIGHTING.

LOUISVILLE, KY.—An electric plant is to be established at Grayson.

LEXINGTON, VA.—The Lexington Light and Power Company will enlarge its plant.

HUBBARD, TEX.—W. A. Bass has secured a franchise to construct an electric light and ice plant.

REDKEY, IND.—The Redkey town board is considering the advisability of installing an electric light plant.

HASTINGS, MICH.—The Thornapple Gas and Electric Company is preparing to expend $20,000 in betterments.

KNOXBORO, N. Y.—An effort is being made to form a stock company to erect an electric light plant for Knoxboro.

CARROLL, IOWA—John Absher, of Wagner, S. D., is contemplating the erection of an electric light plant at that place.

BRIDGETON, N. J.—It is said that there is a movement on foot for the establishment of an electric light plant for Cedarville.

ESSEX, IOWA—The Electric Light and Power Company's plant will be rebuilt, the stock increased by $25,000 and the whole system enlarged and improved.

TACOMA, WASH.—The Tacoma Gas and Electric Light Company has announced its intention of making more than $75,000 worth of improvements this year.

DULUTH, MINN.—J. H. Hilliard has been awarded the contract for the construction of the generating station for the Great Northern Power Company above Fond du Lac. The building will cost about $100,000.

DUQUOIN, ILL.—Dr. T. B. Reagin and James Forester, who were recently granted an electric light franchise by the Duquoin city council, have begun work on the erection of a plant. The system will be installed at a cost of $25,000. The franchise is for thirty years.

COVINGTON, OHIO—Under the provision of a resolution passed by the Covington council the city clerk is directed to advertise for bids for an electric plant for supplying lights for the streets and public buildings of the city. The resolution was passed without a dissenting vote, all members being present.

THIBODAUX, LA.—The municipal plant at Thibodaux is in the market for an eighty-kilowatt, 220-volt, direct-current generator set complete with engine, to be used to replace two direct-current generators of 110 volts on the Edison three-wire system. This set is to be used in connection with a 220-volt generating set.

TECUMSEH, NEB.—At a special meeting of the Commercial Club a motion prevailed unanimously asking the city council to submit a proposition at the coming municipal election for the issuing of bonds in the sum of $9,500 for the installation of a new electric lighting plant in Tecumseh. The present plant, which is the property of the city, is entirely inadequate and out of date. It is proposed to put in a plant that will cost $12,000, the city council being able to provide the difference from other sources.

CHICAGO, ILL.—The proposition submitted to the city by the Chicago Edison and Commonwealth Electric companies is a maximum rate a kilowatt-hour of sixteen cents the next five years, gross; fourteen cents the next two years, net, and twelve cents the following three years, net, as compared with the present gross rate of twenty and net rate of sixteen cents. The reduction ranges from twelve and one-half to twenty-five per cent on a sliding scale. The price to the city is to be reduced from $103 to $75 per year on each arc light.

NEW PUBLICATIONS.

UNIVERSITY OF WISCONSIN—The University of Wisconsin, Madison, Wis., has issued bulletin No. 106 describing the sources of water supply in Wisconsin. This has been prepared by Mr. William Gray Kirchoffer.

MARYLAND GEOLOGICAL SURVEY—The Maryland Geological Survey has issued a special report on the chemical and heat-producing properties of Maryland coals. This gives an outline of the investigations which have been conducted, the methods of analyzing and testing the samples of coal, and a table giving the complete data obtained from the tests.

ELECTRIC RAILWAYS.

WHEELING, W. VA.—The Wheeling Traction Company will extend its present line from Bellaire to Shadyside.

AKRON, OHIO—It is announced that Thomas L. Childs has financed his proposed road between Akron and Massillon.

ST. AUGUSTINE, FLA.—It is stated that the Seminole Power and Ice Company, of Fort Myers, will build a trackless trolley line between Fort Myers and Alva, on the Caloosahatchee, a distance of eighteen miles.

ENID, OKLA.—A fifty-year street car franchise has been granted by the Enid city council to W. L. Spencer & Company, of Enid, which specifies that work must begin in ninety days, and four miles of track be in operation inside of one year.

MILWAUKEE, WIS.—The Chicago & Milwaukee Electric Railway Company, of which A. C. Frost is president, has been granted a franchise by the Milwaukee city council to operate its interurban line to the heart of the business district.

BROOKLYN, N. Y.—The officials of the Brooklyn Rapid Transit Company have planned four new trolley routes for the district of Brooklyn around the twenty-sixth ward. Efforts are now being made to obtain franchises. It has been rumored that the lines to be built are an extension of the Church avenue line, Georgia avenue line and two lines crossing Liberty avenue.

POTTSTOWN, PA.—It is stated that the Schuylkill Valley Traction Company will build a road from Pottstown to Swamp during the coming summer. A route has been surveyed. The road will complete the connection of Philadelphia with Reading. At Swamp connection will be made with the new Boyertown & Pa'm Railway to the Oley Valley line and on to Reading. Many of the rights of way have already been secured.

PHILADELPHIA, PA.—An electric road is to be constructed between Philadelphia and Trenton. It will have direct connection with the Frankford avenue elevated road, to be built by the Rapid Transit Company within the next three years. An agreement for an interchange of traffic has been made. The new road is to be built by the Philadelphia & Trenton Short Line Railroad, incorporated December 15, 1905, in which several officers of the Philadelphia, Bristol & Trenton Street Railway Company are known to be interested.

BLOOMINGTON, ILL.—The Illinois Traction Company has let the contracts for the electrical supplies for the combined power plant to be installed in Peoria, and which will furnish power for the city lines and the line between Bloomington and Peoria. The contract for the transformers was let to the Westinghouse company, of Pittsburg, while the contract for the rotary converters and exciters was let to the General Electric Company, of Schenectady, N. Y. The exact amount of the contracts was not given, but it is said to be close to $100,000.

ALBANY, N. Y.—Articles of incorporation of the Rochester & Elmira Electric Railway Company have been filed with the secretary of state at Albany. The authorized capital stock of the concern is $4,000,000, and it undertakes to build a double-track trolley line from Rochester to Elmira, a distance of 120 miles, to compete with the Erie and the Delaware, Lackawanna & Western railroads for local passenger traffic. Among the directors named in the articles of incorporation are Stanley Gifford, Frederick Eckstein, Horace G. Abel, C. O. Geer, Max H. Schultze, Henry Brunssen, Henry Velthusen, Tracy S. Buckingham and Ralph Wolf, all of New York city.

BUTLER, PA.—A franchise for a route a mile long from the western boundary of Butler borough to Main street has been granted by the town council to the Butler & Harmony Street Railway Company, promoted by Joseph Boggs. The street railway company pays a consideration of $500 a year for the first ten years, and amounts thereafter increasing in proportion to the increase in the population, and also is to build an iron bridge for public use over Sullivan run. Bond in $5,000 is given to begin work within six months. The line will connect Pittsburg, Zelienople, Harmony, Ellwood City, Evans City and Butler. This line will connect with a road to run from Allegheny to New Castle, which is being built by the same company.

INDUSTRIAL ITEMS.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., will be pleased to send to those interested bulletin No. 3060 and bulletin No. 3065, descriptive and illustrative of type "H" hoisting motors and type "I" motors, respectively.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., reports having closed a contract with the Edison Illuminating Company, of Detroit, Mich., for four 500-kilowatt motor-generator sets, to be used for railway service.

THE LOWE ELECTRIC COMPANY, 54 Vesey street, New York city, is calling attention to the necessity of making repairs and overhauling exhaust and fan-motor systems at the present time, getting this work done before the hot weather comes on.

THE COMMERCIAL ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., has published a neat booklet calling attention to some of the telephone apparatus for which it is the agent. The company has recently published a new catalogue, which will be sent to anyone interested upon request.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., in the March issue of "Graphite" presents an article concerning lubrication in textile mills. In addition to this there are several sketches concerning the uses of graphite, and a large reproduction of the Dixon plant at Jersey City.

STANLEY & PATTERSON, INCORPORATED, 40 Cortlandt street, New York city, has ready for distribution a new bulletin descriptive of "Faraday" skeleton bells. These bells have been described from time to time, and their features are well known. The company has recently placed on the market a new type with several improvements, a description of which will be sent upon application.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has recently secured an order from the Illinois Steel Company, Chicago, Ill., for two large gas-engine generating units, twin-tandem type, 1,000 kilowatts capacity each. These machines will be installed in the steel company's present power plant for lighting and power purposes. A four-cycle, double-acting engine, direct-connected to a 1,000-kilowatt Allis-Chalmers generator has recently been ordered for the Crystal City (Mo.) plant of the Pittsburg Plate Glass Company.

THE HYDREX FELT AND ENGINEERING COMPANY, 120 Liberty street, New York city, is supplying "Hydrex" waterproof felt for the excavation for the New York terminal of the Pennsylvania Railroad at New York. The fifty-feet-deep retaining walls around this excavation are being made permanently waterproof with "Hydrex" waterproof felt. "Hydrex" felt is also specified for waterproofing the Pennsylvania Railroad tunnels under New York city. "Hydrex" felt is the basis of the company "membrane theory" of waterproofing, affording elasticity, toughness and strength.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., has closed contracts for switchboards for the following places: Holton, Kan.; Tonopah, Nev.; Nashville, Tenn.; Elkhart, Ill.; Grand Ridge, Ill.; Bryson City, N. C.; Brantford, Ontario, Canada; New York, N. Y.; Sunset, La.; Mount Upton, N. Y.; Carthage, Ill.; Central Square, N. Y.; Marcus, Iowa; Franklin, N. C.; Auburn, N. Y.; Ladd, Ill.; Diagonal, Iowa; Lytton, Iowa; Woodstock, Ill.; Rochester, N. Y.; Seattle, Wash.; Fontana, Kan.; Clarksville, Tenn.; New Cambria, Mo.; Cambria, Mo.; Rupert, Ida.; Elkville, Ill., and Ohio, Ill.

THE HOLOPHANE GLASS COMPANY, New York city, has published two new catalogues of its edition de luxe, describing and illustrating, respectively, the lighting of churches, schools, libraries and hospitals, and the lighting of theatres and public halls. The text is very interesting, and the illustrations show many beautiful examples of the proper use of Holophane products for illumination. Two other publications of the Holophane company which are of interest and importance are a booklet on scientific illumination and perfect lighting, and a special folder describing and illustrating the high efficiency obtained by the use of the new "Pagoda" reflectors for standard eight, ten, sixteen and thirty-two-candle-power lamps. There are three shades for concentrating and three shades for distributing the light.

THE STANDARD ROLLER BEARING COMPANY, Philadelphia, Pa., has increased its capital stock from $2,000,000 to $3,000,000. This increase has been required to provide for an enlargement in the factory and equipment. A four-story factory, 150 by 200 feet, will be erected immediately for the manufacture of annular ball-bearings, on which, the company announces, it holds basic patents. During the past year the company has equipped with machinery a four-story building, 95 by 200 feet; an iron foundry, 70 by 130 feet, two stories in height; a hardening and tempering building, 70 by 150 feet; and a crucible steel-castings plant, 60 by 100 feet. With the new building, which will be erected immediately, the company will employ over 1,000 hands in the manufacture of steel balls, ball-bearings, roller-bearings, automobile axles and annular ball-bearings.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has ready for distribution a March calendar card illustrating General Electric rail-bonds for every condition. These include solid wire-bond, ribbon-bond, soldered head-bond and cable-bond. Price list No. 5143 gives prices on General Electric measuring instruments. Flier No. 2174 describes and illustrates the type RA speed-regulating rheostats for machine control. Supply catalogue No. 7595 illustrates and lists repair parts of GE-61-A and B railway motors. Bulletin No. 4432 describes and illustrates prepayment attachment for Thomson recording wattmeters and high-torque induction meters; bulletin No. 4433, rotary converters for railway service; bulletin No. 4435, isolated plant switchboard panels with circuit-breakers. In addition to this there is a January index to the bulletins, an index to pamphlets, an index to the supply catalogues, and index to fliers, and index to price lists and an errata sheet for bulletin No. 4429.

THE AUTOMATIC REFRIGERATING COMPANY, 22 Thames street, New York city, representing the merged interests of the Automatic Refrigerating Company, of Cleveland, Ohio; the Singer Automatic Ice Machine Company, of Bridgeport, Ct., and the Marshall Ice and Refrigerating Machine Company, of Boston, Mass., is about to remove its office, shop and refrigerating show plant to Hartford, Ct., where provision has been made for greatly increased manufacturing facilities. The company makes a specialty of small refrigerating equipments possessing many unique and valuable features. One of the features in this system is an automatic expansion valve controlling the flow of ammonia; a second automatic valve controls the flow of water to the condenser and a thermostat effects the starting and stopping of the machine as the temperatures require; a safety cutout shuts down the machine and rings a gong in case of abnormal condenser pressures caused by failure of water supply or accidental closing of discharge valves. It is understood that the Hartford address of the Automatic Refrigerating Company is to be 630 Capital avenue.

FRANK B. COOK, Chicago, Ill., announces that he has received the approval of the National Board of Fire Underwriters on the new type B-4 subscribers' station protector. He is now in a position to furnish a device which combines all the most approved forms of protection, and which may be installed in residences and buildings with the full approval of the underwriters' inspectors. The type B-4 protector is equipped with Cook's new tubular fuses, with improved carbon lightning arresters, and with sensitive heat coils. The parts are mounted on a heavy porcelain base. Cook's new tubular fuse does not explode nor flash, and does not continue the arc when blown. The fuses protect against heavy currents. The improved carbon lightning arrester is provided with a perforated celluloid dielectric, in which the perforations are so small and so numerous that the discharge is greatly broken up, and is forced to pass through the arrester at many points. If an arc continues through the arrester, due to a cross with a high-voltage circuit, the celluloid melts and allows the springs to press the carbon blocks together, forming a ground through the arrester. The sensitive heat coils protect against sneak currents, and it is a simple matter to reset the coils after they have operated. The lightning arresters and heat coils are protected from dust and dirt by a glass cover.